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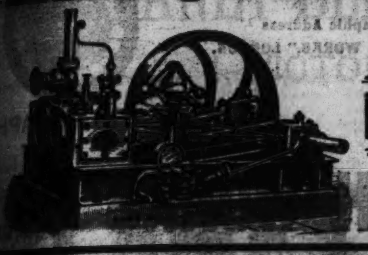

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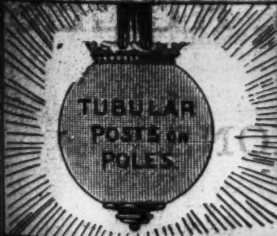

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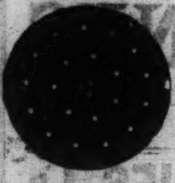
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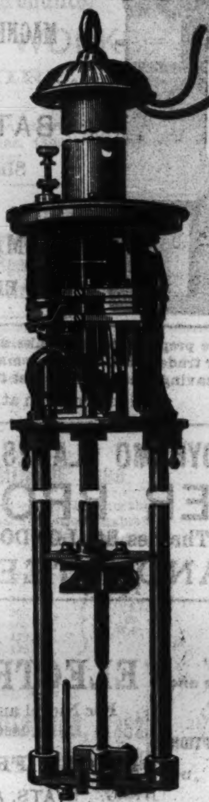

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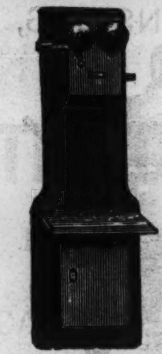

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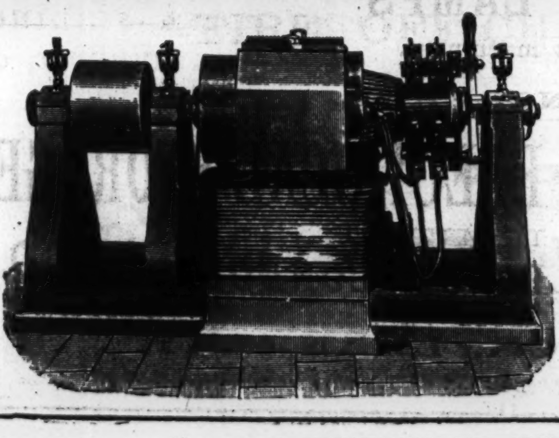

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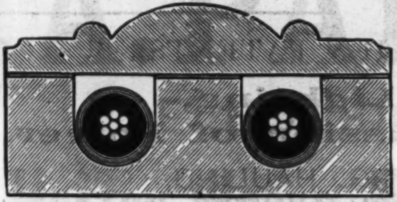

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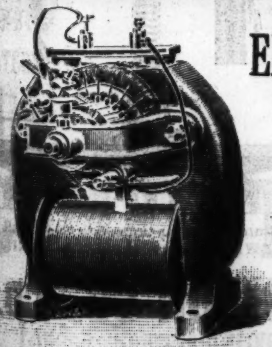

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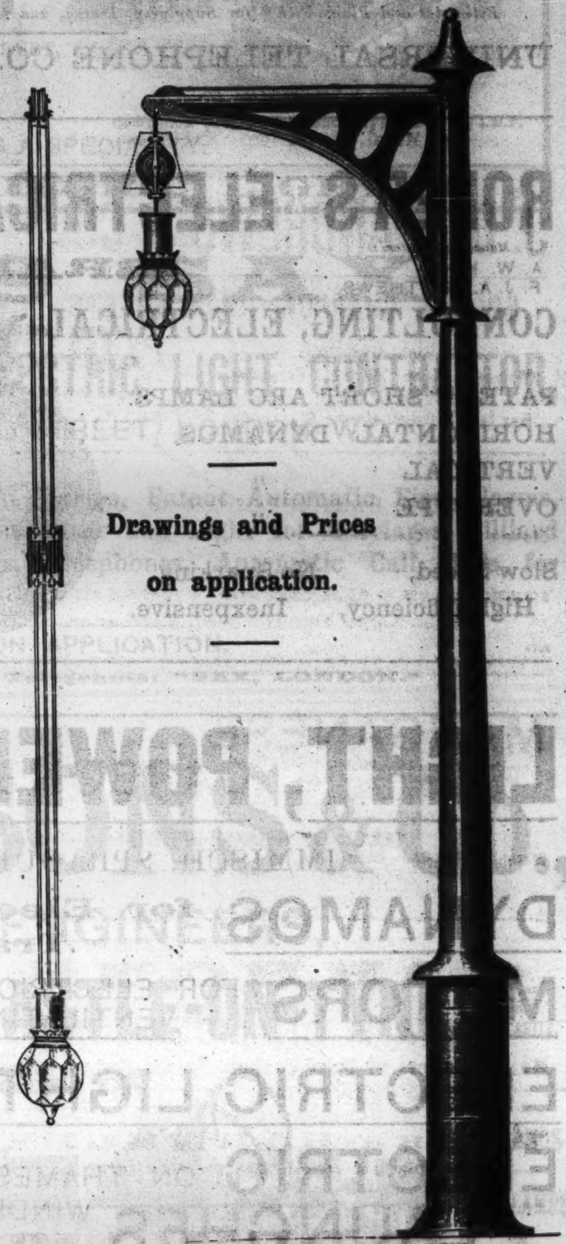

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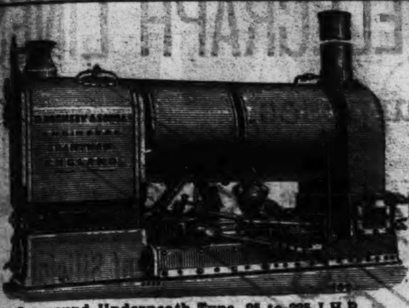

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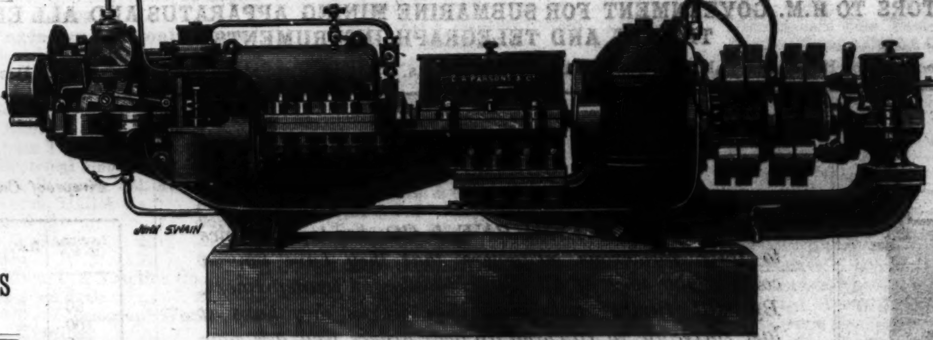

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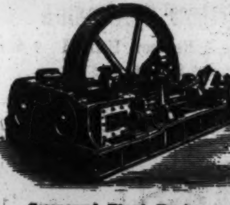

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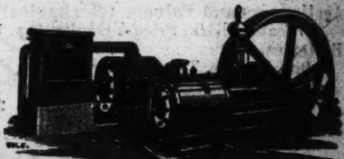

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HENSHAW RUSSELL, *Manager.*

CRYSTAL PALACE, *May*, 1891.

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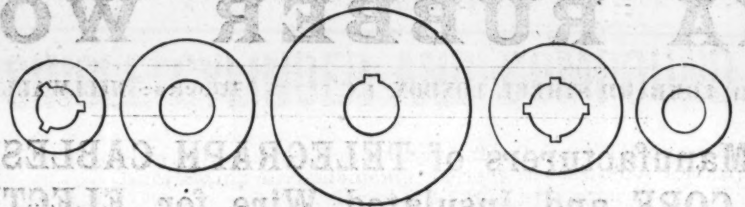

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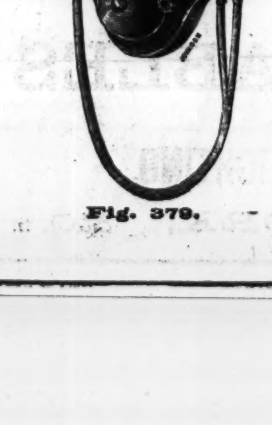

Fig. 379.

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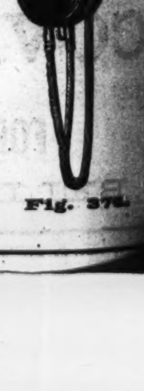

Fig. 374.

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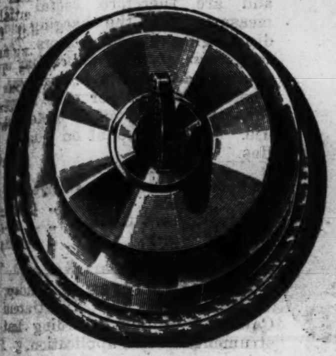

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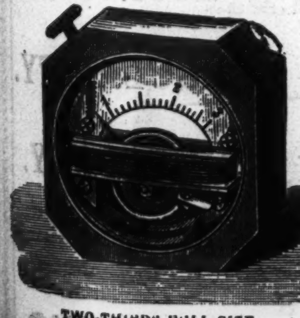

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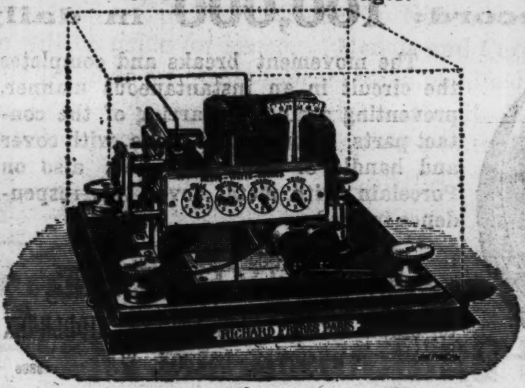

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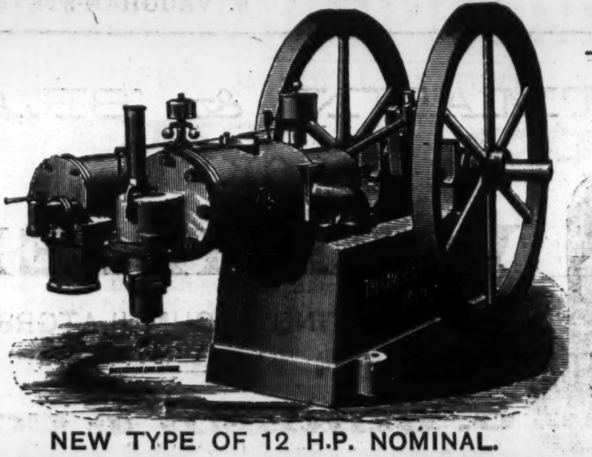

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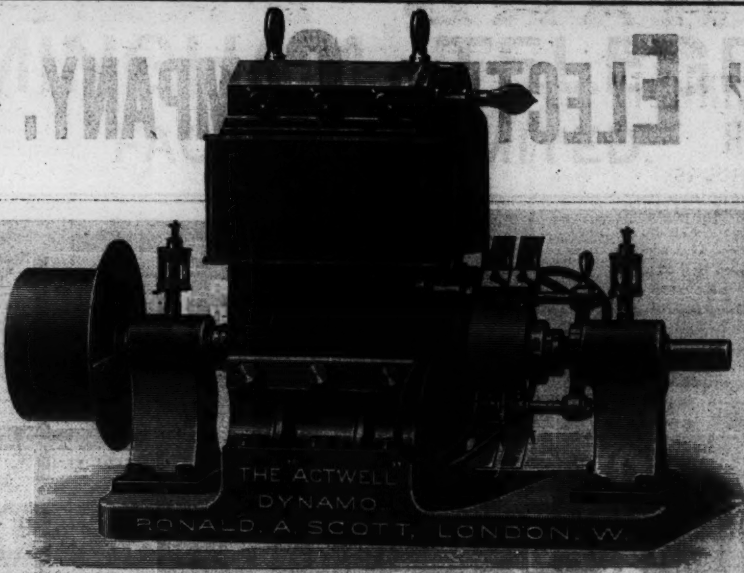
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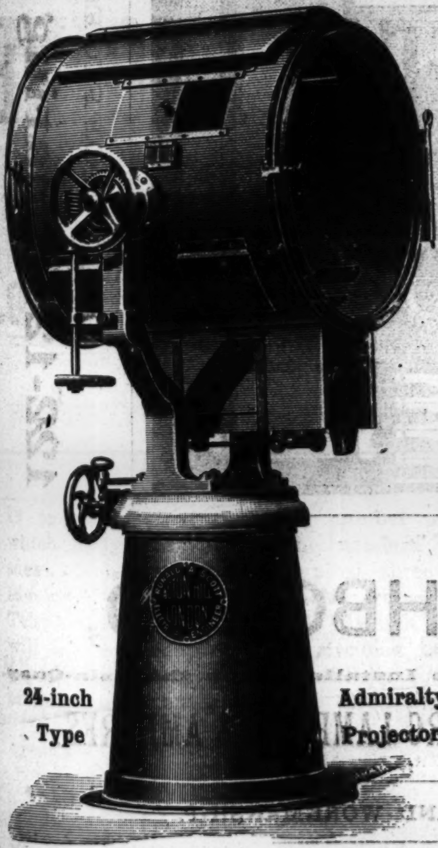

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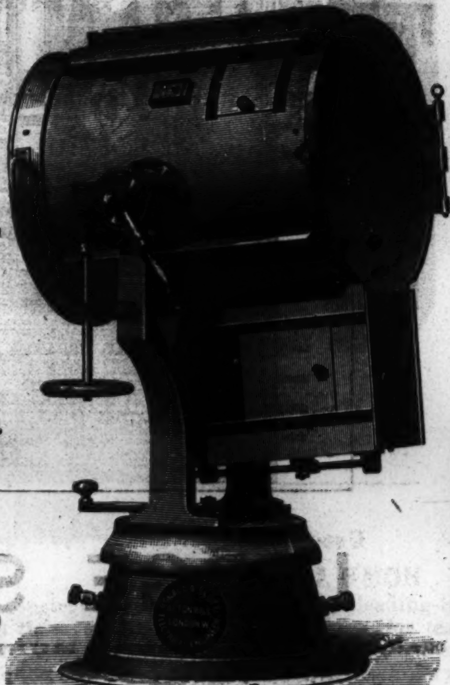

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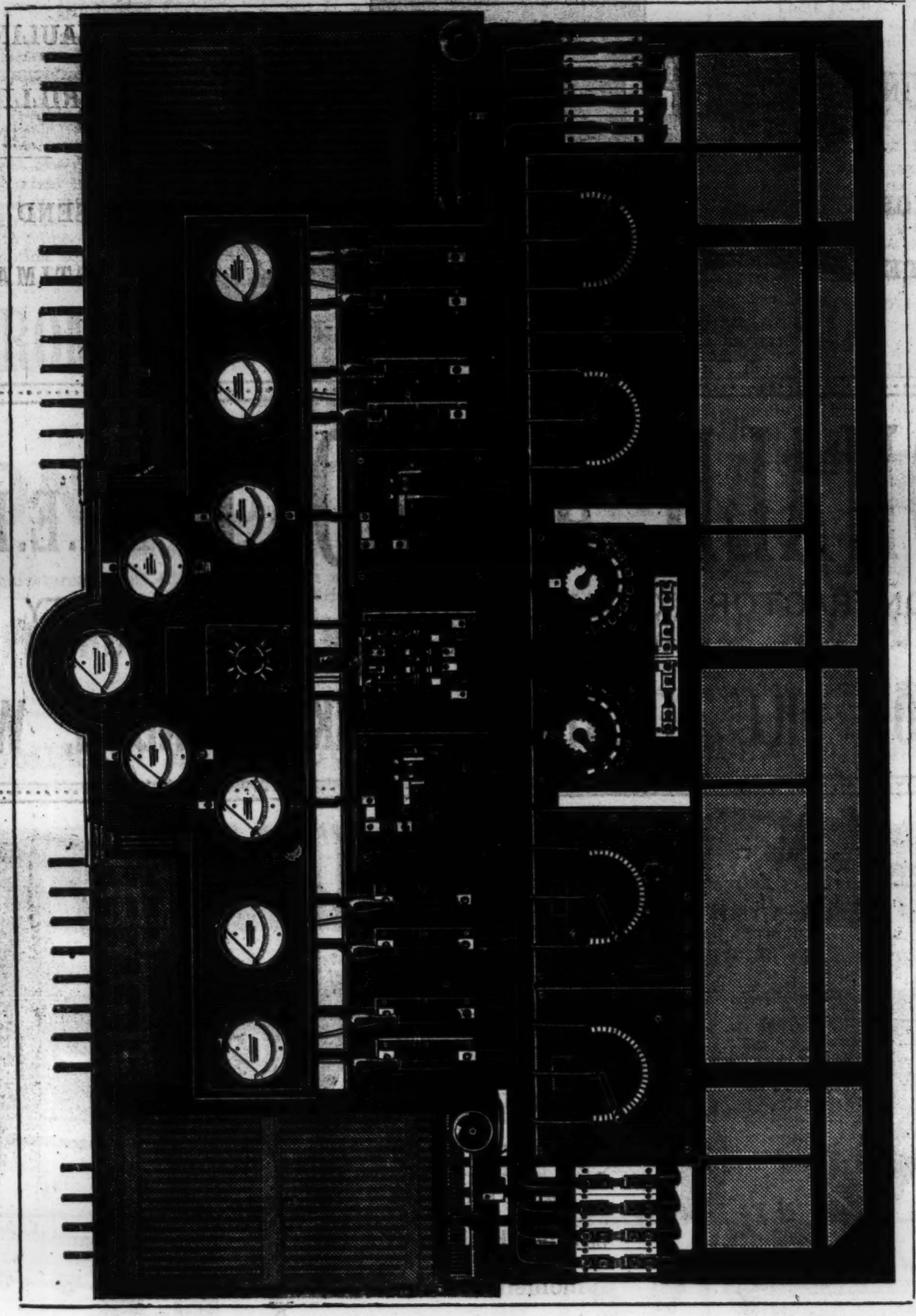

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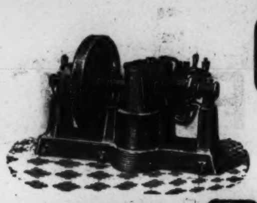

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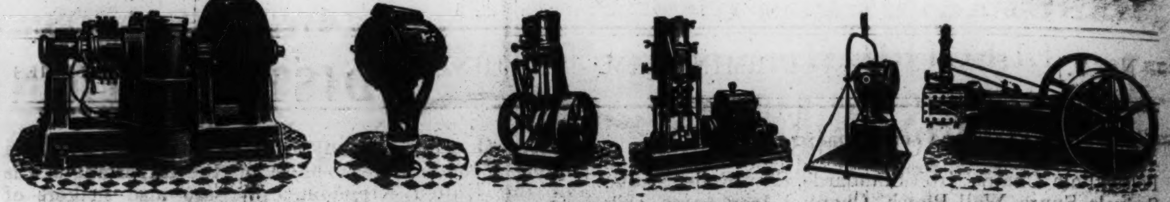

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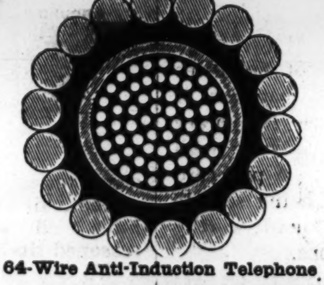

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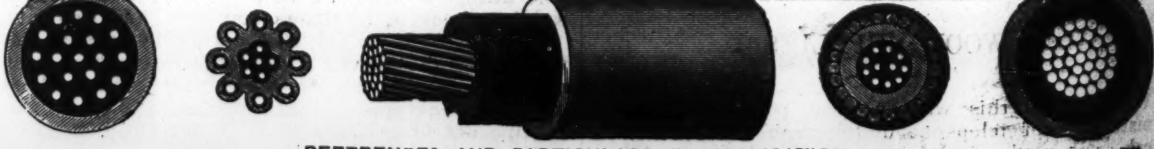

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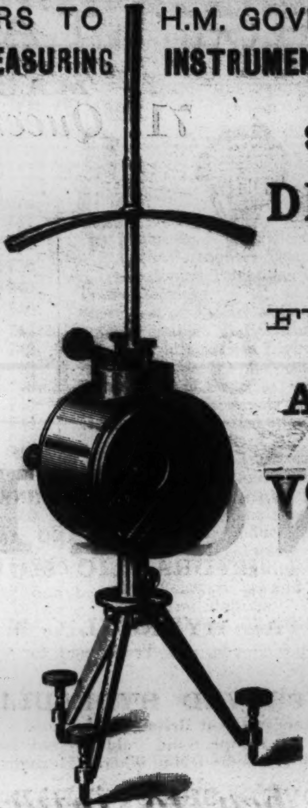

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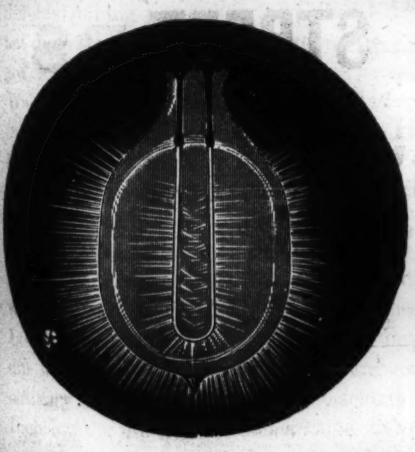

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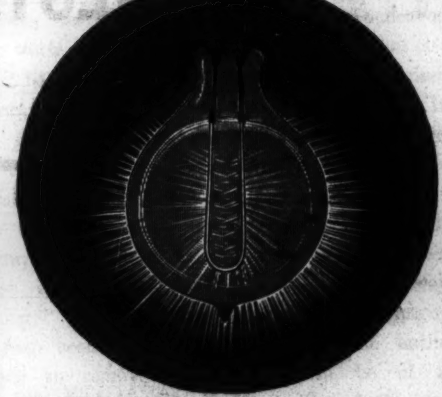

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THE TELEGRAPHIC JOURNAL AND
ELECTRICAL REVIEW.

VOL. XXVIII. JUNE 12, 1891. No. 707

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ELECTRICITY IN MINING OPERATIONS.

SEVERAL years have passed away since electricity was first used in connection with coal mining in the United Kingdom, that occasion being, if we remember rightly, the erection of an underground electric pump in the Forest of Dean. Since then this particular application has been slightly extended, and electric lighting, electric haulage, and electric coal-cutting machines have been introduced. The extent to which electricity has been adopted for these various purposes has, however, been very restricted, and has not answered the expectations of either those who wish prosperity to the industry generally, or of those firms which undertake the supply of electric mining plant. At the present time, the number of installations or applications of electricity to different mining purposes in the United Kingdom is probably not more than fifty. Out of these, no less than twenty-eight are electric light installations in mines located in the South Wales district. In these twenty-eight instances, 1,171 fixed incandescent lamps are in use, and the greatest distance lighted is 365 yards from the bottom of the shaft.

What a contrast the great mining districts in the United States present! There electricity has come into very extensive use for: 1. Drilling in rock and ironstone; 2. In under-cutting coal, the system of using a series of rotating drills being looked upon with most approval; 3. Locomotives hauling underground; 4. Pumping water from dip workings to the shaft; 5. Raising coal in cages of ordinary capacity, or by smaller machines in kibbles; 6. Lighting the mines, &c. Remarkable, indeed, is the enormous development which has taken place in the use of electricity for these purposes; and the substitution of electrical for steam or compressed air plant, which process is going on continually, shows conclusively that the American mine owners have learned that electricity is not only more economical but that it can be adapted to perform work in those parts of a mine where any other agency would be inadmissible. Why has not a similar development taken place in the United Kingdom, and are there any theories which can be advanced to explain the cause of the slow rate of progress made in this country? The answer is in the affirmative.

The first reason is the natural aversion of mine owners to adopt anything new; the second is that they do not generally feel disposed to incur expense in making experiments with small plants; and the third—which is the most important—is that they object, or rather many of them do, to the use of electricity as being unreliable. We will take it for granted that the first two reasons will be generally admitted, but the third may be considered as a bare statement without any foundation in fact. Let us see whether such is the case.

If reference be made to the proceedings of the various societies of which the mine owners, managers and engineers are members, it will be found, when the subject of electricity is brought forward, that the majority of the speakers express the opinion that that agency is unreliable, and no matter whatever an electrical engineer may say in order to endeavour to prove that such is not the case, the impression that electricity cannot be depended upon still remains in their minds. Take, for instance, the recent meeting of the Federated Institution of Mining Engineers, and the discussion which followed the reading of the paper descriptive of an electrical safety apparatus for cages. One of the speakers, in order to try to show the unreliability of electricity, stated that he had a telegraphic apparatus which got out of order every week, whilst another said that batteries were always "going wrong," and so forth. After these damaging statements had been made, the efforts of the author of the paper to remove them seemed to be of no avail. Now, the Federated Institution, although a young society, consists of many gentlemen who have been engaged in coal mining for over 30 years, and it is becoming, if it is not so already, the most important mining institute in the kingdom. Consequently, the opinions of the members may be taken as fairly representative of the feeling throughout mining circles in the country.

It is this wrong impression—this impression as to the unreliability of electricity in mining operations—that electrical engineers interested in mining plant must endeavour to remove, and until such an effort is energetically made the adoption of electricity in the future will proceed but slowly, as in the past. What would doubtless have a good effect on mine owners would be the collection of data regarding each application that has been made in this country, data giving the cost of installation and of working, comparisons with previous methods employed, and general results of working. Figures dealing with these points, and coming from those mines where electricity has already been adopted, would be more convincing than all the arguments in the world; they would not only remove the "unreliability" objection, but would doubtless greatly increase the trade in this branch of the electrical industry.

ANNUAL CONFERENCE OF TELEGRAPH CLERKS.

WE have already in these columns given expression to sentiments of regret that the Postmaster-General, in dealing last year with the grievances and discontent in the Postal Telegraph Service, did not make a better bid for a settlement which could have been looked upon as suggestive of some degree of finality. We do not share the views of commercial and official misanthropes who, steeped apparently to the lips in pessimistic tenebrosity, refuse to recognise that the matter is one capable of satisfactory settlement, because of the vague, undefined demands of the army of clerks in the Postal Telegraph Service. On the contrary, after reading the utterances from time to time of the Postmaster-General, and having a due regard for the philanthropic posing of the right hon. gentleman, we were inclined to entrust too much, as it now appears, to his professions of sentimental ingenuousness, and there is some ground for supposing that the House of Commons adopted this view of a fair and final settlement being possible, and even probable, when Earl Compton brought forward the case of Postal Telegraph clerks in the early part of last session.

Vagueness and uncertainty form no part of the claims of our telegraph operators, and such allegations may be regarded as so many confessions of ignorance of a subject which has now attained to close upon its majority; the incipiency of telegraphic discontent, dating as far back as 1871, charges of doubt, procrastination and uncertainty, if advanced at all, may be, with much greater reason, applied to other and higher factors than the hard working telegrapher.

The Postmaster-General a few weeks since expressed an opinion that whatever was left of agitation throughout the Telegraph Service was largely due to the local action of "expiring committees." Possibly this comforting assurance may have been gradually and gently instilled into the mind of the right hon. gentleman by his well-praised henchmen at St. Martin's-le-Grand, but it is necessary that he should not be misinformed or misled on this point.

The fact is that the scheme, for the initiation of which Mr. Raikes has taken not a little credit unto himself, has failed because of its pieced and patched up nature. Reform and rehabilitation by niggard and uncertain instalments are at best but half-hearted affairs, and bring but poor consolation to those scantily reformed and rehabilitated—and to this fact and not to the anxious and probably disappointed labours of "expiring committees" must Mr. Raikes look for the failure of his remedial scheme of 1890.

If we may so put it, a few more "leads" are wanted to complete a general system of telegraphic contentment. To begin with, the unfair and disheartening system of "classification" should be abolished, and the service in every city and town of the United Kingdom should have a straightaway method of salaried progress which would put an end to the existence of such gross anomalies as are at present to be found in every telegraph office worthy the name.

The only excuse that has been put forward for the classification system is that it enables heads of departments to check the promotion of unsuitable and unqualified persons, but this is in many respects more or less a "delusion and a snare," and on the other hand it comes with great force that "classification" has been and is made the forerunner of advancement by "selection," so that not invariably by "merit" but occasionally by "favouritism" and other unworthy ends whereby the meritorious have to suffer, not for a year or two but practically for the remainder of their official lives, promotion has reached those whose qualifications, it is not too much to say, were conspicuous chiefly by their absence.

The tenth annual meeting of the Postal Telegraph Clerks Association, held in Edinburgh last Saturday, and numerously attended by delegates from all parts of the United Kingdom, will to some extent dispel the idea that there is nothing left of agitation in the Telegraph Service beyond that inspired by some few sections of irreconcilable "expiring committees." Indeed, we hear that the Postmaster-General's remarks have had the undesired effect, so far as he is concerned, of leading to a rejuvenation and reconstruction of the executive committees throughout the service generally. No doubt it has been deemed necessary, in the face of such expressions as the Postmaster-General has from time to time let fall, to protect those at whom they have been aimed, and it is satisfactory to hear that where changes have for obvious reasons been deemed necessary, there has been no difficulty in finding plenty of men endowed with every qualification necessary to the intelligent discharge of serious duties, disinterestedly undertaken. The meeting at Edinburgh, in addition to disabusing the mind of the Postmaster-General on the subject just mentioned, had a good deal to say on the old bugbear of classification, and we may rest assured that nothing short of its abolition will lay the ghost of telegraphic discontent. It says much for the *employés* in the Telegraph Service that they keenly court a general and exhaustive Parliamentary enquiry, and Earl Compton's recent motion on postal matters is by no means the last that will be heard of such affairs in the House of Commons.

There are not a few amongst the vast community around us who think that it is quite time a Minister of Telegraphs was appointed, and that a separate State department of telegraphs is needed; it is quite possible, indeed we think highly probable, that the Post Office, so called, farms too many schemes and concerns, and we are all aware that most of the attempts made to overhaul the Postal Departments generally have resulted only in the reiteration by the Postmaster-General in an injured tone of the statement that "Those gentlemen concerned in every way deserved well of their country."

It is not unreasonable that telegraph clerks should look for outlets for experienced men such as are afforded, for instance, by country postmasterships, inspectorships, &c., and while the telegraph service is tacked on to St. Martin's-le-Grand, there ought to be a fair proportion of such offices judiciously and fairly bestowed on deserving officers in the Telegraph Service. We hope this point will be carried forward fairly, yet energetically, by those chiefly interested, for at present such venues are but seldom opened to those not fortunate enough to be on the postal side of the Post Office system.

The Edinburgh Conference came to the conclusion, and not an unreasonable one, either, that it was its duty to try to oust the individual known as the Postmaster-General's Bogie man, and renewed efforts will be made in this direction. This interesting personage danced attendance at Edinburgh as usual, and whatever the unfortunate individuals who have made postal "Paul Prys" of themselves may have thought of the measured and studied sarcasm of telegraph clerks assembled in solemn conclave, they have little reason to find fault with the measure of practical hospitality freely and fully extended to them by those whose sentences they have had to reproduce for the special information of an anxious Postmaster-General; for we understand that they have always been invited to lay aside their stylus and note book for the more attractive elements of the banqueting saloon.

Questions affecting annual leave and sick pay were also discussed, but space prevents our going any further into details on this occasion.

THE MODERN ORACLE.

When the Pagan dispensation passed away before the advancing tide of Christianity, in the early centuries of our era, many of the customs that had endured for ages lost their hold on the popular fancy, and dropped into abeyance. The land of which Athens was the intellectual centre was no longer revered on account of its shrines from whence issued the answers of the Gods to the questions and supplications of mankind. Kings, States, and people throughout the ancient world in any time of difficulty or perplexity failed not to consult these oracles, and also neglected not to enrich the temples with handsome and costly presents. The answers vouchsafed to their questions were not more ambiguous than they were expensive.

For fifteen hundred years the oracles have been silent, but now after this long lapse of time, and in a city not 100 miles from the modern Athens, once more have their vague responses been heard.

The ancient Pythoness is replaced by the modern electrical consulting engineer. In the olden days it was usual to seek the advice of one oracle only, and in exchange for the heavy fees, obtain an answer satisfactory to the enquirer, while being sufficiently equivocal to cover any event.

The Glasgow sub-Committee for Electric Lighting have applied to three, viz., Mr. R. E. Crompton, Professor Andrew Jamieson, and Sir William Thomson. Between these three stools it must have been hard to maintain a clear course. Their utterances would be difficult for an expert to understand; how much more so, then, when brought before non-technical town councillors.

There is a firm lighting portions of Glasgow by high tension currents who have supplied the limited requirements heretofore. But the Corporation before proceeding under their Provisional Order sought the advice of Mr. Crompton as to the best method of installing the electric light in the area that must compulsorily under the order be lighted within two years. The report, of course, recommended the low tension system, and it was found that so far from presenting a satisfactory scheme for lighting the compulsory area, it advised extending the district to be lighted over a larger area.

The Sub-Committee were puzzled, and this time called in Prof. Jamieson to consult with them. If the Committee hoped the matter to be elucidated by the professor's reports they were doomed to disappointment. The report is lucid and full of details and differences between the various systems, but not a word as to which is the best.

Still perplexed, the Committee applied to Sir William Thomson, and he suggested the low-tension system as best for the compulsory area. Sir William almost in the same breath writes to the company working the present high-tension system, and says that this latter method is the best for large districts, and no other system hitherto either practised or proposed is adapted to supply this kind of demand. No wonder then that the Council are confused and have somewhat stormy meetings and pass resolutions to carry out the installation in accordance with the reports of the three gentlemen above named. This will without doubt mean an additional expenditure in sundry fees on the part of the Corporation of the City of Glasgow.

The name of consulting engineer should alone be used by men who are perfectly independent of all trade influence, and therefore unbiassed. Can this be said of either of the experts employed by the Glasgow Corporation? All know Mr. Crompton and his endeavours to advance the interests of his firm. Does Prof. Jamieson confine himself strictly to his scientific duties? And surely Sir William Thomson is a scientist of too great a reputation to afford to have it said of him that some of his testimonials savour of prospectus reports.

Engine Indicators.

The re-invention of an old idea is by no means an uncommon thing, and though in some cases it is hardly excusable seeing that a little research in the records of the Patent Office would have made it plain that what was thought to be new was in reality not so, yet in many cases there is considerable reason for an inventor having been unaware of his having gone over old ground. Prof. Perry, who has recently devised a form of steam engine indicator, is stated to be one of those who has only revived an old idea. It seems, however, that the latter has not resulted in a practical success, so that if the Professor has been successful he may reasonably claim to have done creditable work. Comparatively little seems to have been accomplished in the matter of these indicators, though the extensive use of high-speed engines would seem to require some radical change in form on the lines followed by Prof. Perry and others. The use of a screen, oil lamp, &c., with the indicator certainly seems objectionable, but this drawback may easily be exaggerated, and if such appliances enable what has hitherto been impracticable, to be accomplished, their use may not be so much of a drawback as imagined.

THE CRISIS OF THE POPP COMPANIES.

[FROM OUR OWN CORRESPONDENT.]

IF present indications are not deceptive, a serious crisis is now at hand for the Popp compressed system, as it has been foretold by the most eminent electricians from the very outset. Hitherto the electro-technical press, in the face of the adherents of Popp and of other interested parties, has been obliged to confine itself to barren theoretical polemics. In this field the representatives of the Popp system were never at a loss for counter arguments. At last the bare facts give their testimony, as the cautious Bourse is now engaged with the financial results of the Popp enterprise, and the Bourse declines to be content with theories.

In the last weeks there have repeatedly appeared brief notes on the hopeless position of the Popp business finances. The *Frankfurt Zeitung*, which is always well informed on matters affecting the money market, writes :—"In view of the conflicting statements on the share taken by the Discount Company in the Popp speculations, the *Berlin Boersen Courier* gives, on the faith of communications from interested quarters, a statement confirming that the International Compressed Air Electricity Company is involved with the *Compagnie Parisienne de l'Air Comprimé* to the extent of 6·8 million francs in shares, and of 5·9 million marks in funds advanced."

The International Compressed Air and Electricity Company is not further involved in the Paris undertaking. Neither the International Company nor the Discount Company has undertaken any future liabilities for the *Compagnie Parisienne*. The interest of the Discount Company in the Paris undertaking is completely exhausted by its participation in the International Compressed Air Company. That sounds satisfactory, but it does not explain why the International Company, instead of attempting in the first place, according to its prospectus, to introduce compressed air installations in Germany, engages its entire capital in a foreign undertaking. Concerning the previous development of the Paris Company, the same paper informs us that the district which has been allotted to the said company for electric lighting involves the best and busiest parts of Paris, especially the great Boulevards. According to the stipulations of the concession the company is bound to complete its net of cables by 1891 in such a manner as to meet all demands for the supply of electric current within the district. The company has not succeeded in doing this, although the expense of the operation has been increased by the forced execution. It was found necessary to establish a compressed air installation near the company's district, as the central station is too remote. Hence the company resolved to erect a new central station close to the banks of the Seine. The completion of the installation has been delayed by about a year, chiefly because the necessary machinery was not delivered punctually by Cockerel and other manufacturers. Hence the company was compelled to use dynamos in several places for their electric working. This has led to differences between the City of Paris and the *Compagnie Parisienne de l'Air Comprimé*. The city is entitled to a certain percentage of the profits from the use of compressed air, whilst for the electric installations the company has to make only one payment for laying the cable. The City of Paris now claims that the Popp Company should compute the entire air drawn in through the compressors as delivered to the electric works, whilst the Popp Company maintains that a great part of the compressed air was expended uselessly during the construction of the buildings, *i.e.*, was simply let escape, and also that an accurate calculation of the air-pressure employed was impracticable during the simultaneous use of dynamos. The City of Paris, by its method of computation, arrives at a clear profit of 800,000 francs in which it has a right to participate according to the concession. The Popp Company, on the contrary, assert that the clear profit did not exceed 200,000 francs, or, indeed, that there existed no clear profit susceptible of participation.

The receipts of the Paris Company were in 1890, for clocks, 87,000 francs (in 1889, 91,000 francs) ; for motive power, 356,000 francs (in 1889, 241,000 francs) ; for hire, 18,000 francs (in 1889, 17,000 francs) ; for electricity supplied, 805,000 francs (1889, 653,000 francs). The working expenses have increased from 209,000 francs to 219,000 francs, so that there is a surplus of 1,049,000 francs, as against 804,000 francs in the previous year. How far this surplus is absorbed by interest, &c., we are not informed. It would have been important to learn what amount has been expended on the Paris undertaking. The paper assures us that further outlays of importance can be incurred only on the extension of the net and the installations. This seems to be contradicted by the fact that in the above summary extensive new buildings are spoken of. In well-informed circles here it is believed that the expenditure of the Paris Company is not yet at an end.

So much appears certain from the information which has reached publicity, that the Berlin Discount Company which is heavily involved in the Popp undertakings is now seriously engaged in reducing as far as possible the great risk which it has undertaken, and that its shares have fallen appreciably in value in consequence of the unfavourable position of the Popp companies having become known.

A curious fact may here be mentioned. The engineer Karda, a representative of the Paris Popp Company, which is applying for a concession in Budapest, recently delivered an address before the Budapest Association of Engineers and Architects, in which he asserted that at present the compressed air motor is the only one which can be taken into practical consideration for supplying towns with energy.

SOME RELATIONS OF ELECTROMOTIVE FORCE TO ATOMIC WEIGHT, CHEMICAL HEAT, &c.*

BY DR. G. GORE, F.R.S.

THE following experiments and measurements were made for the purpose of examining and extending the knowledge of the relations of volta electromotive force to atomic weight, &c. All the measurements of electromotive force were made by the method of balance, with the aid of a suitable thermo-electric pile, and a differential astatic galvanometer having 50 ohms resistance in each coil.

In order to ascertain the influence of variation of the kind of positive metal of the voltaic couple, nearly all the measurements were repeated with four different positive metals. The proportions of substances employed were in all cases chemically equivalent to each other. The proportions of water and of absolute acid, stated in grains, in all the experiments of Table 2, were as follows :—Water 18·0, HI 1·28, HBr ·81, HCl ·365, HNO^3 ·63, and H^2SO^4 ·49 ; but the actual quantities used were, for the sake of convenience, twelve times these amounts. The hydriodic acid was freshly prepared, colourless, and highly pure. Distilled water was used in all cases. In consequence of the great voltaic energy of the halogens, and the small degrees of solubility of iodine and chlorine in water, the solutions of Table 1 were made just one 250th the degree of concentration of those of Table 2 ; they were, however, of equivalent strength amongst themselves ; those of Table 3 were also chemically equivalent to each other. In all the tables the variation of electromotive force due to difference of temperature (6° to 12° C.) was small.

All the experiments and results in each of the tables are so arranged as to facilitate comparisons of the amounts of electromotive force with the atomic weights and amounts of chemical heat of formation and solution of the compounds. In each of the tables, the substances are classed in the usual chemical groups, for it had been found that by arranging them in different ways from this, the relations of the amounts of electromotive force to the atomic weights and chemical heats were obscured and could not be detected ; in each group the members are arranged in the order of their atomic and molecular weights, *increasing downwards*. In the upper part of Table 2, the substances of each group are placed according to the atomic weights of the halogens, and in the lower part according to those of the metals. The amounts of heat given are those determined by J. Thomsen, as produced by the chemical union (and solution) of the elementary substances,

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* Read before the Birmingham Philosophical Society on February 11th, 1891.

TABLE 1.—(Weak Solutions.)

ELECTROMOTIVE FORCES AND LOSSES OF ELECTROMOTIVE FORCE OF HALOGENS BY CHEMICAL UNION WITH HYDROGEN.

	Units of heat.	Sn + Pt.		Al + Pt.		Cd + Pt.		Zn + Pt.	
		E.M.F.	Loss.	E.M.F.	Loss.	E.M.F.	Loss.	E.M.F.	Loss.
Cl	...	∧ 1·27278	...	∧ 1·5959	...	∧ 1·6508	...	∧ 1·9421	...
Br	...	1·19270	...	1·4672	...	1·5135	...	1·8706	...
∨ I	...	·89240	...	1·1240	...	1·1646	...	1·5274	...
HCl	∧ 39,315	∧ ·73796	∧ ·53482	∧ ·9953	∧ ·6006	∧ 1·0130	∧ ·6378	∧ 1·3558	∧ ·58630
HBr	28,380	·70936	·48334	·94954	·51766	·9872	·5263	1·30718	·56342
∨ HI	13,170	·65788	·23452	·8666	·2574	·88432	·58028	1·17562	·35178

The proportion of loss varied from 22·90 to 42·02 per cent.

TABLE 2.—(Strong Solutions).

ELECTROMOTIVE FORCES OF ACIDS AND THEIR SALTS.

Substance.	Units of heat.	Sn + Pt. Volts.	Al + Pt. Volts.	Cd + Pt. Volts.	Zn + Pt. Volts.
Br ...	...	1·2213	1·5816	1·6222	2·0136
H^2SO^4 ...	142,410	·8209	1·08396	1·1646	1·38726
HNO^3 ...	70,665	·8352	1·08320	1·1330	1·4702
HCl ...	∧ 39,315	∧ ·8086	∧ 1·2986	∧ 1·1215	∧ 1·46734
HBr ...	28,380	·7980	1·0954	1·11026	1·3844
∨ HI ...	13,170	·7351	·9667	1·0931	1·3129
AmCl ...	...	∧ ·7065	∧ ·93810	∧ ·9146	∧ 1·2557
AmBr ...	...	·68362	·89520	·8786	1·18134
∨ AmI ...	...	·67504	·86374	·87288	1·0984
NaCl ...	∧ 193,020	·7351	∧ ·9953	∧ ·99586	∧ 1·2557
NaBr ...	171,160	X ·73796	·95526	·8786	1·1842
∨ NaI ...	140,600	·6922	·89806	·8786	1·1413
KCl ...	∧ 202,320	·7494	1·0096	∧ ·98728	∧ 1·2271
KBr ...	180,460	∧ ·7494	X 1·0382	·8956	1·1985
∨ KI ...	150,040	·68934	·9095	·88164	1·16418
RbCl ...	...	∧ ·75512	∧ 1·0096	∧ ·93008	∧ 1·2308
RbBr ...	...	·7351	·9810	·90148	1·20708
∨ RbI ...	...	·6779	·8809	·88432	1·1699
LCl ...	∧ 204,500	∧ ·6922	∧ ·9095	∧ ·9787	∧ 1·1842
LBr ...	182,620	·66932	·8666	·8386	1·03548
∨ LI ...	152,200	·65216	·8523	·8071	1·0126
$CaCl^2$ ...	∧ 187,230	·6779	∧ ·9667	∧ ·95868	∧ 1·17562
$CaBr^2$ ...	165,360	X ·7208	·9381	·9215	1·0412
∨ CaI^2 ...	134,940	·66932	·8566	·88718	·9982
$SrCl^2$ ...	∧ 195,690	·6779	∧ ·9667	∧ ·9644	∧ 1·1985
$SrBr^2$ ...	173,810	X ·6922	·8666	·83856	1·17848
∨ SrI^2 ...	143,460	·6636	·8523	·81568	1·02976
$BaCl^2$ ...	∧ 196,810	∧ ·6779	∧ ·9667	∧ ·97298	∧ 1·20136
$BaBr^2$ ...	174,940	·67218	·8237	·81568	1·18992
∨ BaI^2 ...	144,520	·65216	·8094	·79852	1·04406
$MgCl^2$ ...	∧ 186,930	·66932	∧ ·95812	∧ ·96726	1·16132
$MgBr^2$ ...	165,050	X ·6922	·8952	·86716	X 1·04406
∨ MgI^2 ...	134,630	·66074	·8694	·8585	1·0698
$ZnCl^2$ ...	∧ 112,840	·66646	∧ ·9524	∧ ·96726	1·17216
$ZnBr^2$ ...	90,960	X ·69792	·89306	·88432	X 1·1742
∨ ZnI^2 ...	60,540	·6636	·86088	·87574	1·1556
$CdCl^2$ ...	∧ 96,250	·66360	∧ ·9238	∧ ·9644	...
$CdBr^2$ ...	75,600	X ·72080	·9095	·9358	...
∨ CdI^2 ...	47,870	·66932	·8523	·9215	...
NaCl ...	193,020	·73510	·9953	∧ ·99586	1·2557
KCl ...	∨ 202,320	·7494	∨ 1·0096	·98728	X 1·2271
∨ RbCl ...	...	∨ ·75512	1·0096	·93008	1·2308
$CaCl^2$ ...	187,230	·6779	·9667	·95368	1·17562
$SrCl^2$ ...	195,690	·6779	·9667	·9644	1·19850
∨ BaCl ...	∨ 196,810	·6779	·9667	∨ ·97298	∨ 1·20136
$MgCl^2$ ...	∧ 186,930	∧ ·66932	∧ ·95812	·96726	1·16132
$ZnCl^2$ ...	112,840	·66646	·95240	∧ ·96726	∨ 1·17216
∨ $CdCl^2$ ...	96,250	·66360	·92380	·96440	...
NaBr ...	171,160	·73796	·95526	·8786	1·1842
KBr ...	∨ 180,460	X ·74940	X 1·03820	·8956	1·1985
∨ RbBr ...	...	·73510	·98100	∨ ·90432	∨ 1·20708
$CaBr^2$ ...	165,360	∧ ·72080	∧ ·93810	∧ ·92150	1·0412
$SrBr^2$ ...	173,810	·69220	·86660	·83856	1·17848
∨ $BaBr^2$ ...	∨ 174,940	·67218	·82370	·81568	∨ 1·18992

TABLE 2—(*continued*).

Substance.	Units of heat.	Sn + Pt. Volts.	Al + Pt. Volts.	Cd + Pt. Volts.	Zn + Pt. Volts.
$MgBr^2$ ...	∧ 165,060	·69220	·89520	·86716	1·04406
$ZnBr^2$ ...	90,960	X ·69792	·89806	·88032	∨ 1·17420
∨ $CdBr^2$ ...	75,640	·72080	∨ ·9095	∨ ·93580	...
NaI ...	140,600	∧ ·69220	·89806	·87860	1·14130
KI ...	∨ 150,040	·68934	X ·90950	·88164	1·16418
∨ RbI ...	...	·6779	·8809	∨ ·88432	∨ 1·16990
CaI^2 ...	154,940	∧ ·66932	∧ ·8566	∧ ·88718	·99820
SrI^2 ...	143,460	·66360	·8523	·81568	1·02976
∨ BaI^2 ...	∨ 144,540	·65216	·8094	·79852	∨ 1·04406
MgI^2 ...	∧ 134,630	·66074	∧ ·86374	·85850	1·06980
ZnI^2 ...	60,540	·66360	·86088	·87574	∨ 1·15560
∨ CdI^2 ...	47,870	∨ ·66932	·85230	∨ ·92150	...
Na^2SO^4	257,970	·70364	·91808	∧ ·99300	1·2700
K^2SO^4 ...	∨ 267,180	·71794	·92380	·96440	1·29002
∨ Rb^2SO^4	...	∨ ·73510	∨ ·92952	·94438	∨ 1·30146
$MgSO^4$	∧ 251,510	∧ ·7065	·9238	·9787	∧ 1·16990
$ZnSO^4$	177,420	·70364	∧ ·9238	∧ ·9787	1·15560
∨ $CdSO^4$	161,210	·70078	·9095	·96726	...
$NaNO^3$	216,450	·68016	·9095	·98442	1·17216
KNO^3 ...	∨ 225,930	·68362	·9095	1·0073	1·17848
∨ $RbNO^3$	...	∨ 68648	∨ ·91236	∨ 1·01016	∨ 1·19278
Average ...	...	·639576	·94513	·94586	1·18453

are stated in centigrade gramme calories. The degrees of electromotive force are given in volts. In all cases, the order of *increase* of the numbers is indicated by the direction of the arrows. In order not to make Table 2 too bulky, the relative losses of electromotive force are omitted; they may be obtained by subtracting the electromotive forces of the salts from those of their respective acids in the same table, or in the case of bromides from those of bromine in that table. From the relations and proportions of the numbers in Table 1 to those in Table 2, some conclusions may be drawn respecting the approximate amounts of the losses of electromotive force occurring during the chemical union of chlorine, bromine, and iodine, with equivalent weights of hydrogen and with the metals of the various salts employed.

Conclusions.—Comparisons of the orders of the various series of numbers in Table 2. show—first, that the amount of chemical heat varied inversely as the atomic weight in 14 series and directly in eight, or in proportion to 1·75 to 1·0. 2nd, the amount of electromotive force varied inversely as the atomic weight in 49 series and directly in 18, or 2·72 to 1·0. 3rd, the electromotive force therefore was similarly, but more uniformly related than the chemical heat to the atomic weight. 4th, the exceptional cases in which the electromotive force most often varied directly as the atomic weight, viz., the sodium and calcium groups of metals, were also often those in which the chemical heat varied directly as the atomic weight, *i.e.*, the two conditions frequently varied together. 5th, the electromotive force varied directly as the chemical heat in 51 series and inversely in 13, or 3·92 to 1; this result, and the immediately previous one, confirm the conclusion, that the amounts of electromotive force and of chemical heat are closely connected together. 6th, as the amount of electromotive force varied more uniformly with that of chemical heat than with the magnitude of the atomic weight, it appears to be more directly related to the former than to the latter. 7th, as the electromotive force is manifestly related to the atomic weight, it is probably connected with the periodic series; and 8th, the electromotive forces of the halogens exhibited a more uniform relation than those of either of the groups of metals, to the atomic weights and chemical heats, probably in consequence of the greater energy and more conspicuous differences of energy of the former than of the latter substances. The weakest halogen acid, hydriodic, usually lost the most electromotive force by neutralisation. As both the electromotive force and the chemical heat depend upon each of the two substances which unite together, they are neither of them likely to vary uniformly with the atomic weight of one of the uniting substances alone, nor with that of the other alone, but in a less simple manner.

Usually the electromotive force of a voltaic couple is greater, the larger the chemical heat, the smaller the atomic weight, the less the specific gravity, and the greater the specific heat of the halogen and metal which chemically unite to produce the current; but in the case of the sodium and calcium groups of metals more particularly, the second of these conditions is often reversed; the metals of these two groups are those which have the smallest number of atoms in a given bulk. An examination of the *losses* of electromotive force of Table 3 shows as might be expected, a less distinct relation to the atomic weight and amount of chemical heat than the electromotive forces themselves. The average loss of electromotive force by neutralisation of all the various acids was with Sn ·1052; Al ·1908; Cd ·1901; and Zn ·2388 volt.

The percentages of loss of electromotive force by dilution, which occurred on employing the weaker solutions of Table 1 instead of those of Table 2, which were 250 times stronger, were as follows:—

TABLE 3.

LOSSES OF ELECTROMOTIVE FORCE BY DILUTION.

	With Sn. Per cent.	With Al. Per cent.	With Cd. Per cent.	With Zn. Per cent.
Br	2·35	7·24	6·71	7·10
HCl	8·74	23·36	7·60	7·60
HBr	11·11	13·32	11·08	5·58
HI	10·51	10·36	19·10	10·46

Diluting the stronger solutions to one 250th part of their strength had therefore comparatively moderate effects upon the degree of electromotive force.

ELECTROPLATING THE DEAD.

By A. M. TANNER.

An article has recently been making its round in the scientific and political press of different countries, concerning a newly discovered process of preventing the decomposition of corpses and animal tissues in general by the electrodeposition of metals on the same. It is evident from what follows that this is a revival of a process patented in France many years ago, and thus history has repeated itself in this instance as well as in many others to which I have hitherto called attention in connection with electrical inventions.

The patent in question was issued to Eugene Theodore Noualhier on the 5th day of July, 1856, and bears the title "Application of Galvanoplating to the Human Flesh, for Replacing Embalming of Bodies." The following is a free translation of the specification:—

"I proceed as follows with the cadaver after it is placed into my hands in order to produce the desired result. 1st, I commence by closing all the organs by means of moulder's wax, then I cause the body to assume the position it is to retain and metallise it with a solution of nitrate of silver, which is spread on the previously greased surface of the body. The latter is then placed in a bath of sulphate of copper and I proceed in the same manner as in ordinary galvanoplating operations. After the subject is galvanised I polish it, and it can then be bronzed, silvered, or gilded. The body is thus kept from putrefaction, and it always preserves the same traits and all the finish possible."

It does not appear that this patented process was ever practically applied, and it reminds the writer very much of a description in Maryatt's "Pacha of Many Tales," where sailors on an enchanted island are transformed into mineralized statues by bathing in water prepared by the Circe of the island.

IMPROVED ALLOYS FOR RESISTANCE COILS.

Messrs. K. Feussner and St. Luideck have recently been devoting some considerable attention to the various alloys which are suitable for the manufacture of resistance coils. In the table given below will be found a list of those which have been studied, together with some important figures relating to their specific resistance, coefficient of temperature and composition.

The specific resistance is expressed in microhms for a cube of 1 centimetre dimensions.

ALLOY I.—GERMAN SILVER.

Copper	60·10
Zinc	25·37
Nickel	14·03
Iron	0·30
Cobalt	Traces
Manganese	Traces
Total	99·86
Specific resistance ...	30·00
Coefficient of temperature	0·00036

ALLOY II.—RHEOTAN.

Copper	53·38
Zinc	16·89
Nickel	25·31
Iron	4·46
Manganese	0·37
Total	100·31
Specific resistance ...	52·50
Coefficient of temperature	0·00041

ALLOY III.

OBERMAIER'S NICKELINE (1).

(d = 1 mm.)

Copper	61·63
Zinc	19·67
Nickel	18·46
Iron	0·24
Cobalt	0·19
Manganese	0·18
Total	100·37
Specific resistance ...	33·20
Coefficient of temperature	0·00030

ALLOY IV.

OBERMAIER'S NICKELINE (2).

(d = 0·1 mm.).

Copper	54·57
Zinc	20·44
Nickel	24·48
Iron	0·64
Manganese	0·27
Total	100·40
Specific resistance ...	44·80
Coefficient of temperature	0·00033

ALLOY V.—PATENT NICKEL (1).

(d = 0·6 mm.).

Copper	74·41
Zinc	0·23
Iron	0·42
Nickel	25·10
Cobalt	Trace
Manganese	0·13
Total	100·29
Specific resistance ...	34·20
Coefficient of temperature	0·00019

ALLOY VI.—PATENT NICKEL (2).

(d = 1 mm.).

Copper	74·71
Zinc	0·52
Tin	Trace
Nickel	25·14
Iron	0·70
Cobalt	Trace
Manganese	0·17
Total	100·24
Specific resistance ...	32·80
Coefficient of temperature	0·00021

ALLOY VII.—MANGANO COPPER.

Copper	70·00
Manganese	30·00
Total	100·00
Specific resistance ...	100·60
Coefficient of temperature	0·00004

ALLOY VIII.—NICKELO-MANGANO COPPER.

Copper	72·00
Nickel	3·00
Manganese	24·00
Total	99·00
Specific resistance ...	47·70
Coefficient of temperature	0·00003

It is pointed out by Messrs. Feussner and St. Luideck that all these alloys present a somewhat variable behaviour, and this defect disappears only after successive annealings. From $\frac{3}{10000}$ths to $\frac{4}{10000}$ths in a few days, the variation may still be $\frac{1}{10000}$th after several weeks. The "nickeline" was obtained from the Obermaier factory at Nuremberg; the alloy called "rheotan" was made by Dr. Geitner; the "patent nickel" was made by Messrs. Basse and Selve, of Altona, whilst the alloys VII. and VIII. were obtained from the Isabellen factory, near Dillinburg. It is remarkable that in the case of the last alloy, No. VIII., the coefficient of temperature is negative, and of a very low numerical value. This is a point of great practical interest, which allows us to hope that it may soon be possible to obtain resistance coils for which the coefficient of temperature shall be practically *nil*.

THE COST OF A 16 CANDLE-POWER LAMP-HOUR.

SOME interesting details regarding the working results of the Darmstadt Municipal Central Station are contained in the official report issued by the Town Council. The data given are important, and although published rather late, they are worthy of reproduction. The report deals with the period since the inauguration of the station on the 1st September, 1888, to the end of March, 1890.

It appears that the mains, which are laid underground, are of the lead cased and iron sheathed type, and are about 23 miles long. They have been and are still frequently tested, but a drop in the insulation resistance has not occurred since they were put down. The boilers, engines and dynamos were worked without any interruption in the lighting taking place, but the glass boxes of the accumulators caused frequent cessations in the supply. They were arranged at one end of the boiler house, separated from the boilers by a wooden wall. The glass vessels frequently burst, and caused breakdowns in the lighting. This was remedied by the substitution of wooden cells, which were placed in a separate building, after which (August, 1889) the results were satisfactory. On each consumer's premises an Aron meter was installed, and on the 1st April, 1890, there were 113 meters in use. The report then gives a series of tables concerning the customers. During the year 1889-90 there were 125 consumers, having installed 4,457 glow lamps of from 10 to 35 C.P., and 50 arc lamps, the whole being equivalent to 5,493 incandescent lamps of 16 C.P. In the course of the year 15 more customers were obtained.

From the 1st September, 1888, to 31st March, 1889, the receipts from the sale of light amounted to £2,162, of which £1,159 was from private individuals, and £1,003 from the Court Theatre. Reduced to 16 C.P. lamps, the amount received during the eight months for each lamp was about 11s. 4d., this corresponding to an average lighting period of 283½ hours per annum from private individuals, and from the theatre 6s. 7d. per lamp, or 164½ lighting hours yearly. During the working year, 1889-90, private consumers paid for light £1,644, and the theatre £1,147, or a total of £2,791. Taking the lamps again as of 16 C.P., the sum received per lamp installed in the case of the former was 13s. 5d., showing a lighting period of 336 hours; and in the case of the latter, 7s. 6d. per lamp, giving a duration of 188 lighting hours per annum.

In 1888-89, the consumption of coal per horse-power hour was 6 lbs. 10 ounces, and in 1889-90, 5 lbs. 8 ounces. The boilers were fired with Ruhr coal. There were four dynamos in operation. During the first eight months the number of working hours was 3,295, the output being 842,973 ampère-hours, or 168,594·6 horse-power hours; in 1889-90, 4,902 working hours and 1,108,801 ampère-hours, or 221,760 horse-power hours. The average efficiency of the accumulators was 62·1 per cent. at first, and 57·8 in the second year. This low efficiency was due to the interruptions in the service in the first year, and in the second to the fact that they were not operated at their full output. The total cost of the generating plant, accumulators, cranes, controlling and regulating apparatus, cables, land, buildings, and general expenses in completing the station, &c., was £31,375.

Consumers incurred the expense of making house connections and of the internal wiring, and also paid a rental for the meter. The charge per lighting hour was 4 pfennige, or about ½d. for a 16 C.P. lamp; lamps of other powers being reckoned in proportion to the consumption of current. Renewals of the glow lamps, and the provision of carbons, for the arcs, were provided by the consumers, and generally purchased at the station during the latter portion of the second year. (Previously a tax of 6s. per annum for each glow lamp, and of 25s. for each arc lamp, was imposed to cover this expense.) At the same time a minimum number of lighting hours yearly was fixed. The details as to the receipts and expenditure during 1889-90 are as follow:—

RECEIPTS.

Sale of current	£2,791
Lamp renewal charges	345
Meter rent	42
Sale of arc lamps and carbons	27
Buildings and land [rents?]	45
Putting up of installations	126
Various	11
Total	£3,387

EXPENDITURE.

Interest on capital...	£1,252
Wages	864
Office expenses	46
Allowances	2
Taxes	50
Maintenance of buildings...	17
,, plant	42
Fuel and water	553
Oil, &c.	72
Lighting of the station	75
Maintenance of cables	2
Purchase and maintenance of meters	51
,, of glow lamps	416
,, of arc lamps	23
Maintenance of tools	8
Installations	107
Renewal fund	624
Total	£4,204

The amount of £2,791 received for sale of light is given in the report as 55,822·84 marks, and the charge per 16 candle-lamp per hour as 4 pfennige (about ½d.). If the 55,822·84 marks are multiplied by one hundred, we have that amount reduced to pfennige, of which one hundred make a mark. Thus:

$$\frac{55{,}822{\cdot}84 \times 100}{4} = 1{,}395{,}571 \text{ lighting hours.}$$

The expenditure amounted to £4,204, or, as stated in the report, 84,073·47 marks. If the number of lighting hours are divided into this sum less the receipts from lamp renewals, meter rent, &c. (£596 or 11,924·90 marks), and the result multiplied by 100, the cost per 16-candle lamp per hour comes out at 5·1069 pfennige, or, say, ⅝d. Thus:

$$\frac{84{,}073{\cdot}47 - 11{,}924{\cdot}90}{1{,}395{,}571} = 5{\cdot}1069 \text{ pfennige.}$$

If the cost per lamp hour had been worked out from the figures given in the table in English money, and which have been thus converted from marks at the rate of twenty to the pound, the results would not have agreed exactly with those obtained by using the German method.

FACTS AND FIGURES ANENT ELECTRIC TRACTION.

COMPILED BY A. RECKENZAUN.

(*Continued from page* 678.)

HORSES *versus* ELECTRICITY AT FRANKFORT.

THE Frankfort-Offenbach Electric Tramway has been in continuous operation for seven years, and it appears to hold its own as regards operating expenses when compared with the horse tramways of the same city, working under similar conditions. It has often been stated, and with justice, that it is not fair to compare the traction expenses of tramways in different countries, or even in different cities, since many of the items vary with localities, it is therefore particularly interesting to obtain statistics relating to divers systems in operation in the same city. Such statistics have been furnished by Mr. G. Gallenkamp in the *Zeitschrift für Transportwesen*, from official sources. The herein contained data is all the more valuable since the expenses for all the improvements introduced during the past seven years, as well as all repairs, have been debited to working expenses, the capital account having remained quite stationary. The working expenses for both systems of traction for the year 1890, come out as follows :—

I.—Horse Tramway.

	£	s.	£	s.
Total expenditure			48,395	5
Reserve fund			3,250	0
Total			51,645	5
Less	£	s.		
Omnibus service	2,000	0		
Taxes	832	15		
Municipal charges	1,934	19		
Sundry expenses	1,283	19		
			6,051	13
			£45,593	12

The number of car kilometres run was 2,166,644 during the year, consequently the cost of working per car kilometre amounted to 5·04 pence.

II.—Electric Tramway.

	£	s.	£	s.
Total expenditure			4,958	18
Reserve fund			1,176	4
Total			6,135	2
Less	£	s.		
Watchmen at crossings	82	11		
Lighting the streets	53	1		
Heating cars	17	16		
Taxes, &c.	65	7		
			218	15
			£5,916	7

519,770 car kilometres were made, therefore the operating cost was 2·73 pence per car kilometre.

There are, however, other considerations to be taken into account before we can express the values of the respective systems in their true form. The trains on the Frankfort-Offenbach electric tramway consist of two cars each, one of which is a motor car, the other an ordinary car ; both vehicles carry passengers. If each of these cars were to run detached, then double the number of drivers and conductors would be requisite, and this would increase the expenses by ·54 of a penny per car kilometre. On the other hand the horse tramway has over four times the traffic of the electric line, in round figures 2,166,000 against 520,000 car kilometres, and it is well known that the management, office and certain central station expenses do not increase in the same ratio as the output. These standing charges amounted, in the case of the electric tramway, to £1,100 = ·504 penny per car kilometre. If, therefore, the traffic were quadrupled, this item would certainly not be more than 50 per cent. higher. By raising the management expenses to £1,650 and running 2,166,000 car kilometres per annum, we obtain ·18 penny per kilometre and car. Taking, nevertheless, the figures obtained in actual practice, viz., 2·73 pence per car kilometre, and adding 1·336 pence for additional drivers, conductors and extra labour due to separate motors and gearing, we obtain a total cost of 3·072 pence for electric traction, against the 5·04 pence for horse traction, or a saving of 40 per cent. under precisely similar conditions.

It will be interesting to examine the various items of the balance sheets of both companies in detail. They were during 1890 as follows :—

I.—Horse Tramway.

	£	s.
General stable expenses	14,289	4
Hire of extra horses	887	0
Depreciation of horses...	2,375	9
Shoeing horses	647	4
Harness	529	11
Maintenance of cars	2,731	4
	£21,459	12

This represents the actual "horsing" expenses and car repairs for a total of 2,600,364 car kilometres, but 178,412 of these were made by omnibuses at a cost of £2,943 16s., which must be deducted from the above amount, leaving £18,515 16s., or 2·052 pence per car kilometre.

II.—Electric Tramway.

	£	s.
Engineer's salary	240	0
Wages of engine driver and stokers ...	224	13
Cleaning boilers and engines	35	6
Cleaning cars	53	13
Maintenance of machinery, cars, and overhead line	757	9
Fuel	681	1
Oil and waste	78	19
	£2071	1

This is equivalent to ·956 of a penny per car-kilometre, showing that the keep and depreciation of animals costs twice as much as the electrical energy and maintenance of plant.

These figures, taken from official documents, and based upon results with machinery of comparatively ancient construction, are so conclusive that further comment is quite unnecessary. The Frankfort-Offenbach line was fully described in a paper read at the Society of Arts in April, 1887. This tramway was built by Messrs. Siemens and Halske, of Berlin. The tubular overhead conductor, similar to that exhibited by this eminent firm at Paris in 1881, and which was adopted on several other lines, is used at Frankfort.

New Continental Lines and Projects.

Halle.—The new electric tramway of this city has recently been opened, but owing to the interference on the part of the Postal authorities the traffic had to be temporarily suspended. The line was constructed on the overhead system by the Allgemeine Elektricitäts Gesellschaft, and it is alleged that the working of it interfered with the Telegraph and Telephone service. The tramway company maintains the rights granted by the Municipality, and expects the Postal authorities to remove their wires beyond the influence of the current necessary for working the electric cars.

Bremen.—The Bremen Tramway Company has passed a resolution to substitute electric cars for the present horse cars on all their lines, the short section hitherto in operation (which was built by the Thomson-Houston Company) having given entire satisfaction. The Municipality has sanctioned the use of overhead conductors throughout the city.

Thale-Blankenburg.—A Berlin contractor is about to lay an electric tramway between these small towns, and he proposes to obtain the current of electricity from the Central Lighting Station at Blankenburg.

Breslau.—The Allgemeine Elektricitäts Gesellschaft has obtained the concession to run electric cars with overhead conductors in this city.

Essen.—The Commonalty of this town is now negotiating about the construction of an electric railway to Mühlheim, and declared itself prepared to a 25 years' concession.

Spandau.—The International Electric Company has obtained a concession, for 50 years, to build and work an electric tramway. The construction of the line must commence within three months, and it is to be in operation nine months afterwards. The town takes a small share in the profits of the undertaking.

Berlin.—An extensive project for the construction of an underground railway is in course of preparation, and the concession has already been applied for by Mr. Pötsch, an engineer of Magdeburg. The line is to have 60 stations, and it is intended to use electricity as the motive power.

Wunstorf.—A foreign capitalist has purchased land with the object of building a central electric lighting station, and to construct an electric railway which is to connect this town with the villages of Heidorn, Steinhude and Hagenburg.

(To be continued.)

Multum in Parvo.—The combination of trades to be carried on by the "Farmers' and Cleveland Dairies Company, Limited," the registration of which we publish in the list of new companies, forcibly shows the irresistible power of electricity.

CHARLES'S BRUSH HOLDER.*

WE illustrate herewith in figs. 1, 2 and 3 a very simple and effective form of dynamo brush holder designed by Mr. P. J. Charles, electrician to Messrs. Harland and Wolff, Belfast. By rotating the handle the holder is free to move on the pin of the rocking bar. The brush can thus be readily moved along the commutator to any desired position. A quarter turn of the handle fixes the split sleeve to the pin. The adjustment of the pressure of the brushes is effected by the same handle, and the arrangement has the advantage that the pressure is felt by the hand, so that the attendant knows exactly what pressure he is putting on—an important detail, too often overlooked. To take the brushes off, the handle is turned to slacken the sleeve; the sleeve is turned on the pin and made to grip in a new position. The whole arrangement is beautifully simple and very effective. We have tried this holder and found it admirable, and it is rapidly coming into use.

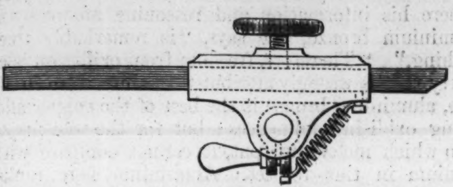

FIG. 1.

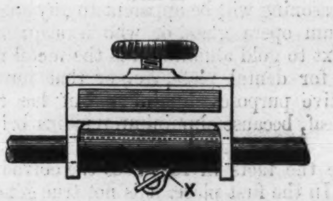

FIG. 2.

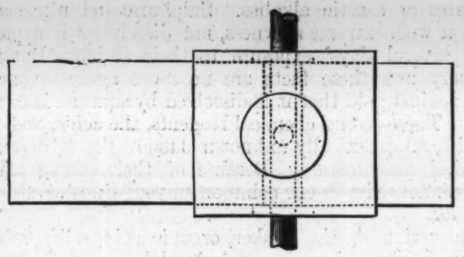

FIG. 3.

THE LIGHTING OF THE CENTRAL STATION AND HOTEL, GLASGOW.

THE Caledonian Central Station and Hotel, Glasgow, are lit throughout by means of electricity. The Brush arc lamps in the station have now been running for six years. They are of the ordinary 10 ampère type, and are suspended at a height of 16 feet above the platforms, and spaced 47 feet apart; the result is a very even and satisfactory distribution of light. The number of lamps employed over the platform is 51, illuminating an area of 112,000 square feet. Eight other lamps are employed at the entrance to the station, and in the yards, &c.

The Hotel and station buildings have just been fitted throughout with incandescent lamps by Messrs. Mavor and Coulson, the work being carried out to the specification and under the superintendence of Mr. A. S. Dunn, telegraph superintendent, Caledonian Railway Company.

There are 1,300 16-C.P. lamps in the Hotel, and 400 in the station buildings, &c. The hotel building consists of two wings in the form of the letter L, and the mains are carried in heavy casing let into the wall of the luggage hoist, which is situated alongside the passenger hoist, close to the junction of the two wings. Each floor is fed by separate mains, and thus heavy T joints and main fuses are avoided in the building. The mains are brought into distributing boxes in the corridors, and are connected each with a copper bar of L section, which is mounted on a slate base. Facing the bar a number of short contact pieces of the same section as the bar are fixed, and to these pieces the ends of the distributing conductors are attached. In the distributing box the connection between the bar and the contact pieces is made by means of a fuse mounted between two copper springs which are attached to a porcelain block. The block is made to push tightly in between the bar and the contact, the copper springs pressing against them. Except in a few special cases there are no other fuses in the branches to the lamps but those just described. The conductors leaving the fuse contacts are 7/21½ cable, and this is carried right down to lamps and switches. Where flexible cord is used this is of 225/40s, so that in no case is a fuse necessary in the ceiling connections or switches. Six or eight lamps are supplied from each 7/21½ cable.

In some cases the number of lamps at a considerable distance from the first distributing box is such that it would not have been convenient to run a sufficient number of 7/21½ branches to feed them. In these cases one or more pairs of fuse terminals are provided in the first distributing box, and a pair of suitable cables run from them to a second distributing box, whence the distribution is effected by means of 7/21½ cables. This system has been employed by Messrs. Mavor & Coulson since 1885, and it is now the general practice of the firm to use nothing smaller than 7/21½ cable or the equivalent of No. 14 B.W.G. for switch and lamp connections.

A good effect and efficient illumination is produced under the railway bridge in Argyle Street. The portion of the street is 140 feet by 60 feet, and 9 200-C.P. "Sunbeam" lamps are used, with 18-inch enamelled iron reflectors above them. The supports for these lamps are hung from spiral springs to avoid possible breakage of filaments by the vibration produced by trains.

The generating plant occupies some of the arches upon which the station is built. Steam is taken from a range of Lancashire boilers, which also supply the laundry, heating apparatus, &c. The pressure is 50 lbs. on the square inch.

The motive power consists of 2 single cylinder engines with cylinders 18 inches diameter by 3 feet stroke, running at 80 revolutions per minute, and one 26 inches by 4 feet stroke, running at 60 revolutions per minute. The two smaller engines have been built by Messrs. Fullerton, Hodgart & Barclay, engineers, Paisley. They are fitted with trip valve gear. The governor mechanism is disconnected from the valve gearing and free to adjust itself accurately to the load until the moment when the trigger engages with the motion rod. Its action is therefore undisturbed except by the unavoidable friction of its own working parts. The larger engine has been converted by the same firm, a similar trip gear and governor being employed to operate grid valves working on the back of the ordinary slide valves, and at right angles to it. The arrangement gives complete satisfaction.

The engines drive by bands three sections of shafting which are ranged in line across the engine room. The ends of the sections are fitted with couplings, but are left uncoupled under normal working conditions, each section being driven by its own engine and having its proportionate load of dynamos. In event of one engine being disabled or requiring repairs, its countershaft can be coupled on to the adjoining section, or the three sections can be coupled into one and driven by the two remaining engines. The pulleys on the countershaft are mounted on four keys with ¾ inch space between the shafts and insides of the hubs, and in order to avoid the necessity for taking off a main belt when a section of shafting is coupled to run while its engine is standing, a cradle is fixed below the driven pulley on the countershaft, which is capable of being raised up to hold it clear of the shaft against the pull of the band.

The dynamos for the incandescent lighting have been built by Crompton & Co., Limited, to Messrs. Mavor and Coulson's specification. There are two 38 kilowatts at 540 revs. per minute. The machines are compound wound, giving a rise of 5 volts at their terminals between one-third and full load, thus compensating for the fall of pressure in the mains as lamps are put on.

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* *Industries.*

The negative terminals of the dynamos are connected to an omnibus bar to which all the negative leads of the distributing mains—11 in number—are connected through fuses. The positives are kept distinct and are coupled to the main ammeter switches. These are connected to the Sir William Thomson ampère gauges, from which the current passes to the omnibus bars. From each bar a connection is made to one of the contacts of the three-way switches. The blades of each switch is connected to a distributing main, and by turning the blade into either of the three contacts the circuit can be changed from one dynamo to the other at will, without making connection with the third *en passant*. The ammeter is provided with flexible leads which terminate in a divided tongue which can be inserted between copper spring clips which are in the circuits. The engineer in charge is able, therefore, to ascertain the current passing to any circuit and to distribute the load among the dynamos as he may wish. Sir Wm. Thomson's voltmeters are provided for each dynamo. The main switchboard, switches, &c., have been designed and the whole of the work carried out under the supervision of Mr. W. B. Sayers, Messrs. Mavor and Coulson's manager.

THE PROPERTIES OF ALUMINIUM.[*]

By CHARLES M. HALL.

IT was stated by Prof. F. B. Crocker in the *Electrical World* of May 16th,[†] in an article on the "Properties and Production of Aluminium," that 99 persons out of every 100 have entirely wrong ideas regarding that metal. This statement I am the more inclined to believe since reading Prof. Crocker's own article. His statements regarding the properties of aluminium are so wide of the mark and so misleading that they ought in the interests of sound information to be corrected. My reasons for undertaking to do this are that I have given a large part of the last five years to this subject, am largely interested in the production and sale of aluminium, and am familiar with its properties as shown by the experience of the past 30 years and by what is being done with it at present.

The main idea of Prof. Crocker's article seems to be that most of the supposed good qualities of aluminium really belong to its alloys and are wrongly attributed to the pure metal. This may be true to a certain extent in regard to the mechanical qualities of aluminium, but it shows a lamentable lack of information to say the same of its chemical qualities. Aluminium bronze of the best grade possesses 100,000 lbs. tensile strength per square inch and correspondingly high elasticity. The saying that aluminium is as strong as steel may have arisen from confounding the strength of aluminium bronze with that of pure aluminium, or it might equally have arisen from what is the fact, that, comparing equal weights, aluminium is as strong as good specimens of steel. Thus the tensile strength of aluminium, 26,000 lbs., multiplied by three for difference in specific gravity, gives 78,000 lbs., whereas the best structural steel ranges from 60,000 to 70,000 lbs. per square inch.

Again, Prof. Crocker says that aluminium has only one-third the strength of wrought iron. He must show a remarkable specimen of wrought iron with a tenacity of three times 26,000 lbs. per square inch. The best quality of wrought iron runs from 48,000 to 50,000 lbs. per square inch tenacity; so that aluminium has over one-half the strength of wrought iron, section for section, and weight for weight is considerably stronger than wrought iron.

I am not trying to prove that aluminium is a suitable material for structural purposes, where strength is the main object. It is not, and neither is any other metal, aside from iron and steel. But aluminium does compare well in strength with other metals, and for purposes where lightness combined with moderate strength is desired, not only will it become useful, but it is being largely used to-day.

It is doubtful if any one has been seriously misled by any confusion between the strength of aluminium and that of aluminium bronze, or if any well-informed person has proposed to displace iron and steel for structural purposes with aluminium.

The most serious objections which Prof. Crocker urges against aluminium are on the score of its chemical properties, and here his information and reasoning are really unique. "Aluminium bronze," he says, "is remarkably free from tarnishing." "Therefore, freedom from oxidation is another property that is wrongly attributed to aluminium itself." It is true, aluminium bronze is the best of the copper alloys for resisting oxidising influences; but for the vast majority of uses to which metals are put, it cannot compare with pure aluminium in this respect. Aluminium here ranks with silver and next to gold and platinum. The fallacy of Prof. Crocker's reasoning will be apparent to any one who possesses an aluminium opera glass, or who is acquainted with the fact that next to gold aluminium is the metal most preferred by dentists for dental plate, &c., or that for sign painting and decorative purposes aluminium leaf has the preference over silver leaf, because aluminium remains bright and silver blackens.

What are the facts in regard to the corrodibility of aluminium? In the first place, it is not true generally that "it is equally attacked by acid?" Of the common reagents, it is dissolved only by hydrochloric acid, and by the alkaline hydrates or caustic alkalies. Sulphuric and nitric acid act upon it with extreme slowness, not dissolving it appreciably after several days' exposure to their action. But for all ordinary uses these facts are no more against aluminium than against gold that it is dissolved by aqua regia or selenic acid. These strong chemical reagents, the acids, and caustic alkalies, are practically unknown outside the laboratory and chemical manufactory. Because of their strong affinities, they cannot exist in our common surroundings of air, water, food, &c.

The action of the weaker, organic acid, saline solutions, &c., upon aluminium is much less than any other metals except the noble metals. Alkaline carbonates do not dissolve aluminium, nor does soap, as Prof. Crocker states. Air, wet or dry, has absolutely no action on aluminium, nor has water. If it is true, as stated by Prof. Crocker, that "subjected to ordinary moist air, aluminium tarnishes and oxidises rapidly," I am unable to see the pertinence of his further remark that "it is not affected by sulphur or sulphuretted hydrogen, which is a great advantage." For a metal that is oxidised rapidly by moist air, there would be small use in resistance to sulphur or sulphur gases. Prof. Crocker states that "the ease of oxidising" of aluminium is "about equal to other metals, such as tin, zinc and iron." The absurdity of this statement would be almost evident to one who had ever seen an article made of aluminium. Think of iron or tin dental plates, or of zinc leaf or sheet iron used for decorative purposes, as aluminium sheet, foil and leaf are employed. Prof. Crocker constantly asserts that "aluminium really has excellent qualities." I am unable to see what they are on his authority.

One of my associates became interested in aluminium financially largely because of an aluminium field glass which he has possessed for 20 years. He has carried it all over the world. It has been wet with sea water and has been almost constantly exposed to "ordinary moist air" for 20 years, and it has never been cleaned or polished further than wiping it with a handkerchief, and to-day it retains its polish and lustre as perfectly as when new. The fact is, that for resistance to all ordinary corroding and oxidising influences, aluminium stands next to gold and platinum and ranks equal to silver, and the difference between it and the latter metal, aside from difference in colour (aluminium being of a bluish tint, which makes silver look yellow by comparison), is just this: For objects that require much handling, aluminium has the disadvantage of losing a portion of its polish, probably from coming in contact with perspiration; but where it is to be exposed to the air of a house or the weather, without much handling, there is no metal which will retain its lustre and polish better. Silver is blackened by exposure to the air, where aluminium is unaffected; while where aluminium is dulled and requires polishing, silver requires the same.

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[*] *Electrical World.*

[†] ELECTRICAL REVIEW, May 29th.

The foreign workers in aluminium seem to have succeeded in giving a more permanent polish and lustre to aluminium under handling than we have in this country; yet, as I judge from some aluminium articles obtained abroad, where polish is unimportant, as for dental plates and culinary utensils, aluminium has no superior short of the noble metals. As regards aluminium cooking utensils, I am not giving this statement off-hand, but from actual experiments extending over more than a year. Cooking utensils of aluminium have been in constant use for the time stated, have been daily subjected to boiling saline solutions, washing with soap, &c., and as a result they are preferred by the users to utensils of any other metal; one reason being that they always are clean and white, while the nickel rivets used for fastening the handles to some of them become perfectly black. In this connection, aluminium cooking utensils will soon be largely placed upon the markets. The same qualities of aluminium are shown by the fact that aluminium vessels have been used for a considerable time for the manufacture of jellies, where freedom from discolouration is important, and besides are now being largely used by one of the large canning concerns in Pittsburgh whose name and products are widely known.

The perfect antiseptic qualities of aluminium should also be noticed, which render it the best metal for culinary uses on this account, and also recommend it for surgical instruments, for which it is largely used at present.

So far as the working qualities of aluminium go, it is well-known to be one of the most ductile and malleable of all metals, and therefore is very easily rolled into sheet or drawn into tubes, or the very finest wire. Naturally possessing such a high grade of ductility, the metal is of a tough nature, such as would not admit of easy working qualities in the lathe or in the planer; but this toughness or clinging tendency of its fibres can be readily overcome and the metal very easily machined by simply alloying with 3 or 4 per cent. of metallic copper, which shortens the grain, but which does not interfere or change the other qualities or virtues of pure aluminium.

I am glad to see that Prof. Crocker truthfully gives aluminium credit for electrical conductivity, comparing equal weights, twice that of copper. This may be of great importance at no distant day, because, comparing equal weights, aluminium has about 12 times the conductivity of iron, and, while it may not soon compete with copper for insulated wire, it is quite likely to compete with iron for telegraph wire, especially when its perfect durability on exposure to the weather is considered, and as hard-drawn aluminium wire can readily be made having a tensile strength of at least 60,000 lbs. per square inch. There is one of the electrical properties of aluminium of which no mention is made by Prof. Crocker, but which is interesting, although it has not been much investigated nor turned to any practical use. This is its resistance to the destructive effects of the electric spark. Aluminium is superior in this respect to all other metals, and for this reason is employed by Prof. Crookes and others for electrodes in vacuum discharge tubes where electrodes of other metals are quickly torn to pieces. The question suggests itself as to its use for commutators and other electrical purposes, where such a quality is most important.

In the last of his article Prof. Crocker makes the strange statement—a kind of "Irish" bull—that "the purity of aluminium does a great deal toward improving its quality," which indicates possibly that the aluminium upon which his article is founded is not aluminium at all, but that metal plus a considerable amount of iron, silicon, sodium or zinc. His remarks would be very pertinent in regard to such a compound. In this connection, it may be stated that it was never easier to obtain aluminium of the purest quality than at present, since the electrical process has been fully perfected.

The conclusion of Prof. Crocker, and of the editorial founded upon his statements, is that aluminium "is not a promising material for practical use." My belief is just the contrary, and it is founded upon a careful study of the metal and upon the practical tests made of its properties extending over several years, and made with large quantities of metal. There is no more promising material for investigation for practical use; and it has been proved that for a multitude of uses the same results in utility, beauty and durability can be obtained from aluminium at a less cost than from any other metal whatever.

In a paper on aluminium read last winter before the Boston Society of Arts, Mr. Alfred E. Hunt, president of the Pittsburgh Reduction Company, in order to give a new turn to a discussion that had fallen into a rut, ventured the statement that aluminium had been overrated, as it has been by some of the unscientific papers. But now every one writing about the metal has taken the cue until aluminium has no good qualities left whatever, but is a weak, easily corrodible metal, like zinc or tin, and really "takes up more space than it is worth," and has falsely appropriated the good qualities of its alloys. Aluminium has been overrated. There has been a kind of "glamour" associated with it due to two facts; the first being that it is really useful, durable and beautiful, combined with the other fact, which has little to do with its commercial importance, that is, its ores are more abundant than of any other metal, and constitute a large portion of the earth's crust.

The world has been centuries in learning to use other metals; in learning to roll, draw, temper, and polish them. Aluminium is new, but we are learning how to deal with it; how to secure the qualities of strength, hardness, ductility, lustre, &c., where required, much more rapidly than has occurred in the history of the other metals.

EXPERIMENTS ON THE RATIO OF ELECTROSTATIC TO ELECTRO-MAGNETIC INDUCTIVE DISTURBANCE BETWEEN NEIGHBOURING TELEPHONE CIRCUITS.[*]

By A. E. KENNELLY.

I.

The following experiments were made with the object of not only verifying the experimental results obtained by Mr. J. J. Carty, as stated in his recent interesting paper on "Inductive Disturbances in Telephone Circuits," read before the American Institute of Electrical Engineers, but also to check within fair quantitative limits the deductions from these results by reference to theory. It would seem that both these aims have been reasonably fulfilled.

Three hundred and five metres (1,000 feet) of double conductor gutta-percha cable, shown full size in the diagram, fig. 1, were laid out on the ground in a figure roughly representing a complete rectangle of sides 30 and 120 metres in length. The cable thus afforded two complete and independent circuits by the interior and exterior copper strands. The insulation between these was 20,000 megohms at the end of one minute, and their mutual electrostatic capacity 0·075 microfarad, from measurements taken at the time. The insulation of the outer strand to ground was about 4,000 meghoms.

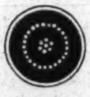

Fig. 1.

The following data give the dimensions of the cable employed:—

Inner Strand.

7 copper wires each	0·025″ = 0·064 cm. diam.
Strand diameter	0·102″ = 0·259 „
Diameter G. P. core	0·175″ = 0·445 „

Outer Strand

18 copper wires each	0·036″ = 0·091 „
Strand diameter	0·247″ = 0·627 „
Diameter G. P. core	0·370″ = 0·940 „
Diameter over braiding	0·425″ = 1·08 „

Conductor resistance of inner strand 2·42 ω at temp. of test (12° C.).
„ „ „ outer „ 0·5 ω „ „ „

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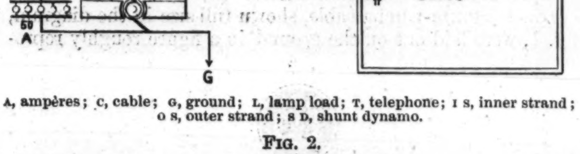
[*] *Electrical Engineer*, New York.

The interior conductor was used as the primary or inducing circuit, and the exterior conductor as the secondary or recipient circuit.

The transmitter or source of disturbance was a continuous current dynamo giving 125 volts at its terminals (shunt wound), supplying about 50 ampères to incandescent lamps, and with one side grounded. A simple harmonic variation of electromotive force would, of course, be preferable for quantitative measurements, but there is some experimental difficulty in creating such a variation having the necessary frequency, while if the pure sine wave of disturbance is relinquished, and the exact shape of the wave is neglected, a dynamo becomes a very convenient transmitter. The small fluctuations in its E.M.F. produced by the successive reversal towards the external circuit of each armature coil as it passes under the brushes, are periodic variations whose frequency will be equal to the number of bars passing under each brush per second, and conversely it is only necessary to join a telephone across the mains of a continuous current circuit (through protecting resistance of say 10,000 ohms), to hear a note in the telephone whose frequency corresponds to the number of commutator bars passed over in one second by one brush. A trained musical ear will often identify this note, and thus the frequency, very closely, and the principle may be practically useful for distinguishing circuits operating at the same continuous pressure, but served by generators of different type, or to ascertain the speed of a dynamo armature when the number of its commutator bars is known. In this instance the telephone note was identified by the use of Helmholtz resonators as nearest to e''' of 1,303 complete periods per second. By measuring the revolution speed of the armature, the number of bars passing under the brush per second was 1,257. This number was therefore taken as the frequency of the periodic disturbance in these experiments.

Various combinations of the two cable circuits were tried so as to obtain electrostatic induction only, electromagnetic induction only, or both together. Of these the two most important cases bearing on the question are shown in the accompanying diagrams. Fig. 2, shows the arrangement of circuits in which electrostatic induction is almost wholly active, and fig. 3, the case in which electrostatic induction is negligible, electro-magnetic induction being displayed to full advantage.

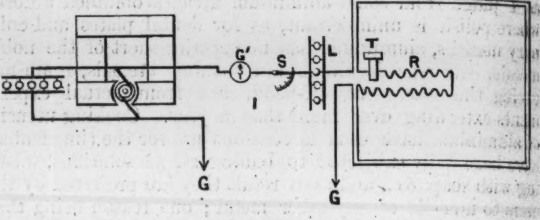


A, ampères; C, cable; G, ground; L, lamp load; T, telephone; I S, inner strand; O S, outer strand; S D, shunt dynamo.

FIG. 2.

Referring to fig. 2, the dynamo is connected directly to the interior conductor, while the exterior is connected to ground through a Bell telephone having a resistance of 73 ohms and an inductance of 113 h. The dynamo note was heard in this telephone. The effect was not due to leakage, because a battery of 50 volts replacing the dynamo, and working through an interrupter, produced no sound. The disturbance was therefore accepted as wholly electrostatic. It required a very large resistance in circuit between the telephone and ground to bring the note down to the limit of audibility. With resistances of graphite, the amount needed to reach this limit was found to lie between 2 megohms and 10 megohms. It was estimated at 7 megohms.

In fig. 3, the dynamo is shown connected through a galvanometer and bank of lamps to the interior conductor of the cable, the other end of which is grounded. The only appreciable inductance in this primary circuit is in the dynamo armature. Inductance is capable of being inserted between the galvanometer and lamps at will. The outside conductor completes its own circuit insulated from the ground through the telephone and resistance. Corresponding to different strengths of current in the primary circuit, resistance is added in the secondary circuit to bring the sound in the telephone down to the limit of audibility.



G, ground; G' galvanometer; I inductance; L lamps; R, resistance; S, switch; T, telephone.

FIG. 3.

The results are given in the following table.

1 Current in primary circuit (ampères).	2 Resistance in primary circuit (ohms).	3 Inductance added to primary circuit (millihenrys).	4 Impedance in primary circuit (ohms ω_1)	5 Resistance in secondary circuit (ohms).	6 Inductance in secondary circuit (millihenrys).	7 Impedance in secondary circuit ohms ω_2)	8 $\omega_1\ \omega_2$
0·522	239·7	—	240	80,000	113	80,000	$1·92 \times 10^7$
0·740	169	—	169	110,000	—	110,000	$1·86 \times 10^7$
1·419	88	—	88	200,000	—	200,000	$1·76 \times 10^7$
2·608	47·9	—	47·9	400,000	—	400,000	$1·92 \times 10^7$
2·774	45·1	4·96	59·7	110,000	—	110,000	$6·57 \times 10^6$
2·868	43·6	37·9	302·5	20,000	—	20,000	$6·05 \times 10^6$
2·608	47·9	0	47·9	400,000	—	400,000	$1·92 \times 10^7$

The first column gives the observed steady currents in the primary circuit, from which, since the pressure was 125 volts, the resistances in the second column are found. The third column gives the inductance (in coreless coils of copper wire) added to the primary circuit, and from these with a frequency of 1,257 periods, the impedance inserted in the primary circuit to the variations of its E.M.F. are given in column 4. In column 5, appears the resistance added to the secondary circuit in order to quench the dynamo note in the telephone, and since the only appreciable inductance in the secondary circuit was that of the telephone, negligible in series with the large resistances, the impedances of column 7 are only repetitions of those resistances.

The last column gives the product of the primary and secondary impedances. This value is nearly uniform except for the cases in which inductance is added to the primary circuit. The marked discrepancy in these two cases is perhaps due to the shunting action of the load circuit supplied by the dynamo, which, being nearly inductanceless, would reduce the periodic current in the primary circuit below the calculated amount, in about the ratio here represented. For the same reason the inductance of the dynamo armature (about 0·3 h) has not been taken into account.

It appears, however, probable from an inspection of the results, that with a resistance of 7 megohms in the secondary circuit, it would be necessary to reduce the primary circuit resistance to about three ohms in order to just render the dynamo note audible in the telephone.

The dynamo in these experiments was at a distance of about 250 feet from the telephone, and silence was obtained in every experiment as soon as the wires leading to the dynamo were disconnected from the primary circuit.

II.

We may now check the previous results by calculation. The check can only be a rough one because we shall have to assume that the periodic variation of E.M.F. is a simple harmonic function of time, and that the inductance of the dynamo armature is negligible.

Let e, be the E.M.F. generated by the dynamo at any instant.
K, the mutual electrostatic capacity of the two circuits.
M, the mutual electromagnetic capacity of the two circuits.

p, the pulsation of the periodic variation of E.M.F. $(2\,\pi\,n)$
$n = 1{,}257$.
γ_c, the current in the secondary circuit at any instant in fig. 2.
γ_m, the current in the secondary circuit at any instant in fig. 3.
ω_1, the impedance of the primary circuit.
ω_2, the impedance of the secondary circuit.
r_2, the resistance of the secondary circuit.
All expressed in A.E.M.U.

Then in fig. 2, if no resistance existed in the secondary path to ground, we should have

$$\gamma_c = -\,\mathrm{K}\,\frac{d\,e}{d\,t} = -\,p\,\mathrm{K}\,\mathrm{E}\cos p\,t \qquad (1)$$

where E is the maximum ± periodic variation of e; but with resistance r_2 inserted as shown, the current becomes very nearly

$$\gamma_c = -\,\frac{\mathrm{E}}{r_2}\cos p\,t \qquad (2)$$

In the case represented by fig. 3, we have

$$\gamma_m = -\,\frac{d\,e}{d\,t}\,\frac{\mathrm{M}}{\omega_1\,\omega_2} = -\,\frac{\mathrm{M}\,p\,\mathrm{E}\cos p t}{\omega_1\,\omega_2} \qquad (3)$$

and

$$\frac{\gamma_c}{\gamma_m} = \frac{\omega_1\,\omega_2}{\mathrm{M}\,p\,r_2} \qquad (4)$$

Also since γ_c was adjusted to estimated equality with γ_m, we should have

$$\omega_1\,\omega_2 = \mathrm{M}\,p\,r_2 \qquad (5)$$

where $\omega_1\,\omega_2$ was $1{\cdot}9 \times 10^{25}$
r_2 „ 7×10^{15}
p „ $7{\cdot}9 \times 10^{3}$

and M calculated for two circuits forming a rectangle of 12,000 × 3,000 cms. is nearly $2{\cdot}0 \times 10^{5}$
$\therefore\ \mathrm{M}\,p\,r_2 = 1{\cdot}1 \times 10^{25}$.

The two members of equation (5) were thus experimentally of the same order although the agreement is by no means close.

It may be fairly concluded that when two insulated wires run parallel and close together, a periodic E.M.F. acting on the circuit of one is liable to induce disturbances in the other, of which the greater part will be due to electrostatic effect, unless the product $\omega_1\,\omega_2$ is less than the ratio of their electromagnetic to their electrostatic mutual capacity.

For parallel copper wires suspended at the same height above ground, and both using ground return circuit, this ratio is, in A.E.M. measure,

$$\frac{\mathrm{M}}{\mathrm{K}} = 3{\cdot}6\left\{\left(\log_\epsilon \frac{2\,h}{r}\right)^2 - \left(\log_\epsilon \sqrt{1 \times \frac{4\,h^2}{d^2}}\right)^2\right\} \times 10^{21}; \qquad (6)$$

where r, the radius of each of the wires (in cms.).
„ d, is the distance between their axes (in cms.).
„ h, is their common elevation above ground (cms.).

This ratio increases with the intervening distance, d, so that the closer the wires, the greater the electrostatic effect. The maximum value the ratio can attain under practical conditions is about 5×10^{23}, so that the product of the impedance in ohms of the primary and secondary circuits should not exceed 500,000 if magnetic induction is to be in the ascendant. Thus, if the primary circuit has 1,000 ohms impedance, the secondary should not have more than 500 ohms.

The particular pair of circuits experimented with in this case, favoured electrostatic action more than would be usually the practice of overhead circuits, for the ratio M/K was only $2{\cdot}67 \times 10^{21}$, making the limiting ohmic product of the two circuits 2,670 ohms, while M/K is commonly about 2×10^{23} for a pair of pole lines, increasing the range of the ohmic product to 200,000. It is also to be observed that when the impedance in the primary circuit is small, and especially when it is situated at the transmitting end of the line, the variation of electrostatic potential, and consequently induction, will be greatly reduced, and the above rules for estimating the proportion of static and magnetic disturbance only approximate the truth when the impedance of the primary circuit is large, and particularly when situated at the receiving end of the line.

As the lengths of the circuits increase, the greater will be the electrostatic share of disturbance, all other conditions remaining constant.

It is remarkable how small a mutual electrostatic capacity suffices to establish audible telephonic inductive disturbance of static nature, between two conductors. In fact, when the resistance to ground of the secondary circuit happens to be very high, the disturbance due to a small mutual static capacity would be hardly, and often inappreciably, increased, if the two circuits were connected metallically.

For with the connections of fig. 2,

$$\gamma_c = \frac{\mathrm{K}\,\dfrac{d\,e}{d\,t}}{\sqrt{1 + p^2\,k^2\,r_2^{\,2}}} \qquad (7)$$

and when r_2 is more than ten times $1/p\,k$ this becomes very nearly

$$\gamma_c = \frac{p\,k\,\mathrm{E}\cos pt}{p\,k\,r_2} = \frac{\mathrm{E}\sin\left(pt + \frac{\pi}{2}\right)}{r_2}, \qquad (8)$$

and this is the strength of current that would be set up in the secondary circuit if the E.M.F. acted upon it directly.

As an instance of this, it was found that if the dynamo above mentioned were connected directly with the telephone through a condenser of 0·001 microfarad, and a resistance of 2·5 megohms in simple series, the clearly audible dynamo note was not appreciably strengthened by short circuiting the condenser. In fact, substituting these values in the last equation with $7{\cdot}9 \times 10^3$ for p, the ratio of the current without condenser to that with condenser in circuit is 1·0015 on the assumption of a pure sine variation of E.M.F. The same result should have followed with a condenser of only 0·00016 microfarad, allowing a ratio of 1·05 between the two currents as the limit of audible appreciation. This experiment can be verified with a few feet of gutta-percha covered wire lying on the ground as a condenser and a graphite resistance in circuit with the telephone, after precautions are taken to ensure the necessary degree of insulation in the wire and instrument.

A NEW ELECTROLYTIC SEPARATION OF ZINC.

Dr. Kosmann and Messrs. Th. Lange and Brieg have recently proposed a new electrolytic separation of zinc, capable of being applied on a large scale. Briefly, we may describe the essential features of this process as follows:—It consists in the simultaneous preparation of metallic zinc and of solutions of sulphuric acid, by electrolysing solutions of the sulphite of zinc or other soluble salts of this metal in the presence of free sulphurous acid, the latter being employed either in the form of a gas or a liquid.

The sulphurous acid, SO_2, is obtained on the large scale in the roasting of zinc blende, which is practically zinc sulphide. It is either kept in solution in water, or else used as soon as produced, being passed into the electrolytic bath.

In the separation of zinc on the large scale by this process, the zincic mineral is partly roasted in the presence of some form of carbon, or even any organic *débris*. It is then crushed and well mixed with water, either in a vat or revolving drum. The powdered mineral is kept in suspension in the liquid by constant agitation, and at the same time sulphurous acid gas, arising from the roasting of other zinc ore is passed in; the result is the formation of sulphite of zinc.

The liquid is now exposed to electrolysis, either in the same vessel, or after removal, to a more convenient receptacle, and while electrolytic action is going on, sulphurous acid gas is still passed in, so that all the oxygen that is produced during electrolysis becomes used up in the formation of sulphuric acid.

This process is deserving of attention, for it aims at using waste products, and so combining them that loss is reduced very considerably.

A NEW PROCESS FOR ELECTROLYTICALLY DEPOSITING ZINC AND ALUMINIUM.

THE special feature of this new process, which has been recently devised by Kaselowsky, of Berlin, consists in the composition of the electrolytic bath; this is composed of the following ingredients, namely:—

Sulphate of zinc	10 kilogrammes.
Sugar candy or glucose ...	5 "
Water	100 litres.
Sulphate of aluminium ...	200 grammes.

In order to obtain the metallic deposits from this bath, it is only necessary to employ a very feeble current; but care should be taken that its intensity does not vary while it is being used.

The strength of the bath is recuperated now and then by the addition of fresh quantities of the soluble salts of zinc and aluminium.

Kaselowsky has also obtained very good results by using a bath composed as follows:—

Chloride of zinc	6 kilogrammes.
Glucose or sugar candy ...	5 "
Water	100 litres.
Chloride of aluminium ...	350 grammes.

In this process the anode is formed of a plate of zinc.

A NEW FORM OF STANDARD CELL.*

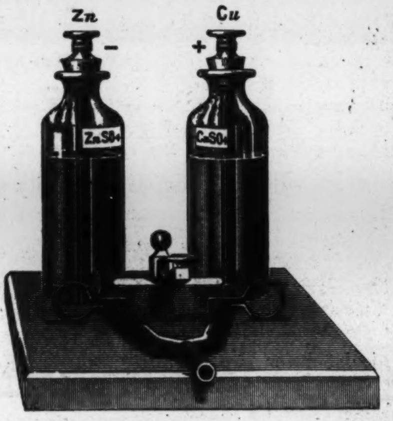
BY CARL HERING.

THE standard cells used at present may be said to be limited to the Clark cell and the Daniell cell. Each one of these has its specific advantages and disadvantages. The Clark cell is always ready for use, but is difficult to make, is affected by temperature, and has the important disadvantage that if by accident it is short-circuited it polarises so rapidly and so much, that it is of no use at all until it has been allowed to rest and recuperate for some time. Such accidental short circuits are not unlikely to occur, and they may furthermore occur, by the crossing of two wires, for instance, without the knowledge of the operator, thus making it possible that the measurements made with it are incorrect. The Daniell cell, on the other hand, does not polarise at all, it may be short-circuited and used almost immediately afterwards; furthermore, it is very easy for anyone to construct a Daniell, and it is practically independent of temperature. But it has the important disadvantage that it must be freshly set up just before using and cannot be kept standing. In their good and bad qualities, therefore, the two cells are diametrically different.

The object of the present form of cell is to try to combine all these good points in one and the same cell. As the polarisation of the Clark cell is an inherent fault and cannot be remedied, there remains only to endeavour to devise a form of Daniell which is always ready for use. The difficulty is due to the fact that there are two liquids which must be in contact with each other; these liquids will tend to mix, and if they mix to the slightest extent only, the cell can no longer be used as a standard. The difficulty therefore resolves itself to a means for enabling two liquids to be in contact without mixing. Numerous forms of Daniell cells have been devised with this object, but they accomplish it only in a degree, as for instance, by capillary tubes, porous diaphragms, &c., all of which, however, do not prevent mixing, but merely diminish the rapidity of the mixing.

In a number of these forms, in which two bottles or reservoirs are connected together by a tube, the mixing takes place quite rapidly unless the pressure of the liquid is exactly the same in both bottles, a condition not always easily complied with.

Some time ago the writer had occasion to use a cell of this form devised by Prof. Barker, which consisted of two bottles containing the two liquids with their respective electrodes, the bottles being connected at their bottom by a small tube with a stopcock. This cock was opened only during the moment when the cell was being used. But even during a few seconds no small amount of mixing took place, especially if the pressure was different in the two bottles. It is very difficult to avoid the latter, owing to the different specific gravities of the liquids and their different heights in the two bottles. The writer therefore modified this form by inserting two stopcocks in this tube and allowing the portion of the tube between the two cocks to communicate directly with the air, as shown in the adjoining cut. By this means the liquids, which mix at their contact, are allowed to drain off as rapidly as they mix. As there is an outward flow of the liquids through the cocks, the mixed liquids cannot pass back into the bottles. The liquids in contact with the electrodes will therefore always remain pure. To prevent too rapid a flow, which would needlessly waste the liquids, some filter paper, cotton or asbestos, is packed into the tubes. The intermediate tube may be drained completely, there is always a film of liquid sufficient to answer for a contact if the cell is used on open circuit, which is the only way any standard cell should be used. It was even found that the film of liquid through the cocks, when closed, was sufficient to give an electromotive force which, however, falls as soon as the slightest current is allowed to flow.



The internal resistance of such a cell is naturally quite high, from 10,000 to 20,000 ohms, but this is no disadvantage for the usual class of open circuit testing.

The E.M.F. of a Daniell cell, according to a report of Dr. Fleming, is as follows: when the specific gravity of the zinc solution is 1·2, and that of the copper is 1·2, when the zinc is amalgamated, and the copper is freshly electroplated with an untarnished, salmon-coloured coating, having no brown spots, the E.M.F. is 1·105 true volts at about 16° C. The temperature correction is negligible. The solutions and metals must be perfectly pure, and the solutions made with distilled water and filtered, being diluted to the required amount after filtration.

Such a cell may be kept standing indefinitely, and is always ready for use. The only remaining objection is that the copper electrode does not remain clean. It should be freshly electroplated, before using, which is readily done in a test tube with a platinum anode. To overcome this, the writer suggests to amalgamate the copper, and when not in use to keep it in a tube of mercury. Whether this introduces other objections has not yet been tested.

Another modification suggested is to place in the bottom of the bottle containing the zinc solution a quantity of pure zinc scrap, not in contact with the electrode. Similarly, copper scrap in the other bottle. Should any mixture of the liquids take place, they will be freed of their impurities by these metals, which, not being in contact with the electrodes, will not affect the E.M.F.

In experimenting with this cell a curious phenomenon was noticed which does not appear to be known. It was found that the slight pressure produced in the bottles by inserting the corks at the top, produced decided differences in the E.M.F. of the cell; this was noticed for each of the liquids, and was different in the two cases. It was therefore found essential to use a cork with a hole through it, so as to prevent this pressure from being exerted. The effect of this pressure has since been investigated by a very extended and interesting set of experiments made by Prof. Hermann Hering, and will form the subject of a paper to be read by him following this one.

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* Read at the stated meeting of the Franklin Institute, Electrical Section, held February 24th, 1891.

ELECTROSTATIC IMAGES.

AT one of the recent sittings of the French Physical Society, M. Hospitalier presented a method suggested about two years ago by Mr. Chapman, of the Adelaide University, South Australia, for producing electrostatic images. This method, which is very simple, gives surprising results, and will be of great service to professors. The images are produced by means of acicular crystals of sulphate of quinine, held in suspension in an insulating liquid, such as the essence of pure terebenthine. The essence is placed in a crystalliser to the depth of 5 or 6 millimetres, and mixed with the crystals until the liquid assumes a milky appearance; if a brass sphere connected with a Wimshurst electrostatic machine is placed at one end of the crystalliser, and another brass ball, connected with the other pole, is placed at the other extremity, as soon as the machine is set in motion, the crystals are polarised and join each other, end to end, forming, between the spheres, very well-defined lines of induction. These lines show up very well when they are projected on to a black ground. The experiments can be varied at will and extended indefinitely by changing the number and forms of the conductors placed in the crystalliser. The fact that there is no field in the inside of a hollow conductor can be clearly proved by connecting the two spheres of the foregoing experiment with the machine, and placing between them a ring of metal. The lines of induction are then seen very distinctly to go from each sphere to the ring, but the liquid within the ring preserves its milky appearance, the crystals of sulphate of quinine not showing any tendency to become polarised. The only condition that is indispensable to success is, that the spirit of turpentine should be very dry. M. Hospitalier has also obtained very clear images by using cofferdam in benzine and even talc. He exhibited before the Society some photographs of these images obtained with the assistance of Messrs. Garbe and Mareschal, either by forming the image directly in the gelatino-bromide plate in the liquid itself, or by placing the plate under the crystalliser, or, lastly, by means of an ordinary camera obscura arranged vertically.

The accompanying figures are reproductions of direct photographs of two images thus obtained.

M. Mascart described another method which he has employed for some time for the production of electrostatic images. It consists of sticking on a sheet of glass the two conductors, brought to different potentials, between which the lines of force are to be defined. By dropping from a certain height on to the plate little pieces of fine wire, 1 to 2 millimetres in length, cut into a sheaf, these pieces arrange themselves according to the lines of force.

AN ALTERNATE CURRENT POTENTIOMETER.*

BY GEORGE S. MOLER.

THIS device is designed for the purpose of determining what values of the potentials of alternating currents will produce given effects, and is intended to be used mainly in calibrating alternating current voltmeters. It may also be used as a voltmeter, applying it directly to the alternate current to be measured. By means of this apparatus we may determine whether the instrument which is being calibrated changes its reading for other rates of alternations. This is shown by comparing the calibration curves obtained by using widely different rates of alternations.

The instrument, briefly described, is as follows: An incandescent lamp is so arranged and connected that it can be switched back and forth from the terminals of an alternating current line to those of a direct current line, which can be altered in voltage till the lamp glows with the same intensity when fed by either line. Then, while switched into the direct current line, the voltage of that line is measured by a direct current standard voltmeter or potential instrument, and the voltage so read is equivalent to that of the alternating current, which produces the same effect in the lamp. The switch is so constructed that it snaps back and forth, making the change of connection so quickly that the slightest change of intensity of the light can be easily detected. The lamp has a blackened hood with an opening in one side through which it is viewed while the sliding resistance is being adjusted. This enables the observer to make a much closer setting than otherwise. A very close setting may also be made by observing the slight reflection of the light from the blackened surface of the hood.

The lamp and switch are arranged and connected in the following manner: Referring to the diagram, A, is the alternate current dynamo, or line, of which we wish to determine the effective difference of potential in volts between its two terminals, B and C; D is a storage battery or direct current dynamo of higher voltage than the alternate current to be measured. A switch, E, made to snap back and forth by means of a stiff spring, changes the incandescent lamp,

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* A paper read before the American Institute of Electrical Engineers, New York, May 21st, 1891.

F, from the alternating current to the direct current, and *vice versâ*. By connecting the two extremities of a resistance, H, to the battery, D, and sliding the contact point, I, such a place can be found that the intensity of illumination will be the same for both currents.

After the contact, I, is adjusted, the standard voltmeter, G, is read while the direct current is flowing through the lamp, and this voltage is taken as the equivalent voltage of the alternate current.

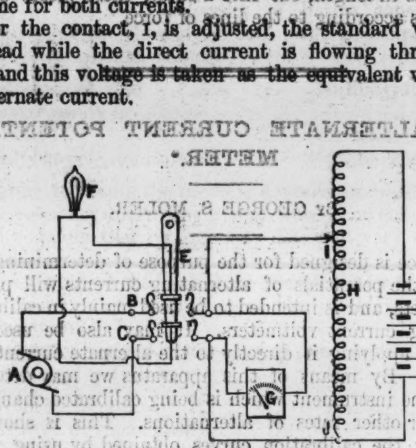

DIAGRAM OF METHOD OF MEASURING ALTERNATING CURRENT POTENTIAL.

A series of lamps of different voltages affords a greater range to the instrument than could be obtained with one lamp only. These may all be connected to the switch, and, beginning at the one of highest voltage, one after another may be tried till the best one is found.

For higher voltages than the highest voltage lamp will stand, a number of lamps may be used in series, and the fall of potential for all, or for each individual lamp, can be measured by means of its voltmeter.

The resistance, H, must necessarily be great enough in amount so that only a small current will be allowed to flow through it, so that the consumption of energy will be small.

Instead of having the switch and lamp connected in a shunt line to the resistance, H, it may be connected in series with H, which must then be arranged so that it can be varied in amount. If a source of constant potential large enough in amount is available, the apparatus may be used for a voltmeter for direct or alternating currents. To use it in this manner, we calibrate the apparatus to find the potentials at the terminals of the lamp for different positions of the contact points, I and J, and construct a curve, using the positions of I and J as abscissæ, and the differences of potential of those points as ordinates. Then, when using the apparatus as a voltmeter, we read the values from this curve instead of from a voltmeter connected to the switch.

The apparatus was tested in the following manner to determine its sensitiveness, and to what extent its indications can be relied upon: The terminals, B and C, were connected to the same resistance, H, by two other contact points, and these connections were changed several times to include different amounts of that resistance. Each time this was done the contact point, I, was moved along till the lamp seemed to indicate the same candle-power for both positions of the switch. The readings of potential for both positions were then made upon a standard potential galvanometer which has a scale graduated to millimetres, and upon which a double deflection of one centimetre means one volt. Upon this instrument readings could be estimated to one-tenth of a millimetre, giving volts to the second decimal place. The accompanying results were the first part of the first set taken in this manner, and were consecutive. They were taken without any preliminary practice. From this it will be evident that the adjustment of the light can be made to within one-tenth of a volt.

Left contact.	Right contact.	
Volts.	Volts.	Diff.
29·95	29·85	+ ·1
29·62	29·60	+ ·02
33·07	33·11	− ·04
37·56	37·55	+ ·01
42·52	42·60	− ·08
60·95	60·90	+ ·05
74·68	74·72	− ·04

A NEW METHOD OF MEASURING INSULATION RESISTANCE.[*]

By GEORGE W. PATTERSON, JUN.

THE usual methods of measuring insulation resistance, having failed to give satisfactory results when used in testing a sample of insulated wire, it became necessary to seek for another. The method which was finally used has certain resemblances to two others, namely, the direct deflection and the fall of potential methods, which are well known; but as it avoids the principal fault of each of these methods, at least when applied in this case, it seems original enough to be worth communicating.

The fault of the direct deflection method is that, if the wire has an insulation resistance, of, say, over a hundred thousand megohms, it is very difficult, using an electromotive force of less than several hundred volts, to obtain a galvanometer which is at the same time both sensitive enough to give a large deflection, and stable enough to give a constant zero reading. The fault of the second method is, that an insulated wire of even short lengths, if connected with a source of electricity, will go on increasing its charge for several minutes at a considerable rate, and sometimes for even an hour at a measurable rate. This increment does not increase the apparent charge; for part of the charge has become, for the time being, latent. It is said to be absorbed. This absorbing goes on even after the source of electricity is removed. A charge, once absorbed, is not readily given up; consequently a wire will appear to have leaked all that has been absorbed between the time its charging ceases and the time it is discharged.

The sample of insulated wire, the subject of the experiment, was one thousand (1,000) feet in length, and No. 18 B. & S. gauge. In the course of the experiment it was found to have an insulation resistance of about ninety thousand (90,000) megohms, and a capacity of about eighty-two thousandths (0·082) of a microfarad. In order to insure its being well wet, it had been kept for several months in the tank of water in which it lay during the experiment.

Neither method being considered sufficiently accurate, it occurred to me that the first method might be so varied as to avoid the small readings and still use no greater E.M.F. The variation consisted in charging the wire and, having insulated it, to allow the leakage to go on unreplaced for a suitable period of time and then to measure the quantity of electricity which was needed to charge the coil as before; for, although the deflection of the galvanometer was too small to be accurately read, if the leakage from the wire was continuously replaced, yet when the leakage for a period of even a few seconds was replaced in an instant, the throw of the needle became considerable. In order to simplify the calculation, a ballistic galvanometer was set at such a distance from the telescope and scale that each mm. of deflection corresponded to one-thousandth (0·001) of a microcoulomb. The constant of any ballistic galvanometer is obtained by dividing the quantity of electricity producing the throw of the needle, by the number of scale divisions of the deflection. The quantity of electricity is measured by the product of the capacity of the condenser and the E.M.F. of the cell used. In this case we used a Carhart-Clark standard cell of 1·440 volt E.M.F. to charge an Elliott condenser of $\frac{1}{10}$th (0·1) of a microfarad capacity. The condenser was then discharged through the galvanometer, giving a reading of 144 mm. Or, expressing the constant in the form of an equation,

$$K = \frac{V_{sc} \cdot C_1}{D_1}, \tag{2}$$

where V_{sc} = the E.M.F. of the standard cell; C_1 = the capacity of the condenser; and D_1 = the reading of the galvanometer.

K is also equal to $\frac{Q_2}{D_2}$, where Q_2 and D_2 are any quantity of electricity and the corresponding deflection, respectively. Therefore

$$Q_2 = \frac{D_2}{D_1} \cdot V_{sc} \cdot C_1. \tag{3}$$

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[*] Abstract of Article in the *Electrical Engineer*, America,

The wire was then connected with a storage battery of 62·5 volts, and to insure its becoming fully charged, was left on closed circuit for half an hour. Next the galvanometer was introduced into the circuit, and at some carefully noted time the circuit was broken. After a certain period, say, 30 seconds, the key was closed for an instant and the throw of the galvanometer was noted. After another like period a second reading was taken, and so on for a considerable time. It may be remarked here that the fall of potential is so slight in short periods, that the deflections are, within the limits of errors of observation, proportional to the lengths of the periods; consequently, even if there should be large variations in the lengths of the separate periods, the summation of the readings for, say, five minutes will remain practically a constant. This constant for five minutes was found to be within two of 210 (210 ± 2), which would make the value for a period of 30 seconds within two-tenths of 21 (21 ± 0·2).

It was noticed that if, the readings were begun before the charge had become practically a maximum, that the readings were somewhat larger, but became rapidly less, and in the course of half an hour had almost reached their minimum. If considerably longer periods were chosen, it was noticed that there was a perceptible falling off even after an hour; but for the shorter periods of 30 seconds this falling off was not noticeable after half an hour.

The usual formula for rate of loss of charge is

$$\left(\frac{d\,\mathrm{Q}}{d\,t}\right) = \frac{\mathrm{V}}{\mathrm{R}}, \qquad (4)$$

where $\left(\frac{d\,\mathrm{Q}}{d\,t}\right)$ is the first derivation of the charge with respect to the time, and V and R are the E.M.F. and the insulation resistance respectively. If, during a time t, the change in the value of V, $[\mathrm{V}_o - \mathrm{V}_t]$, is so slight as to be negligible, then

$$\frac{\mathrm{V}_o}{\mathrm{R}} \pm \frac{\mathrm{Q}_o - \mathrm{Q}_t}{t}, \qquad (5)$$

when the subscripts o and t denote, respectively, immediately after charging and after a further time t.

If D_2 is the deflection produced by the quantity $(\mathrm{Q}_o - \mathrm{Q}_t)$, then

$$\mathrm{Q}_o - \mathrm{Q}_t = \mathrm{D}_2 \,.\, \mathrm{K}\,; \qquad (6)$$

consequently, by equations (2), (5) and (6),

$$\mathrm{R} = \frac{\mathrm{D}_1 \,.\, \mathrm{V}_o \,.\, t}{\mathrm{D}_2 \,.\, \mathrm{V}_{sp} \,.\, \mathrm{C}_1} \qquad (7)$$

Taking the average reading for thirty seconds to be within $\frac{2}{10}$ths of twenty-one [21 ± 0·2] mm., we have in this case

$$\mathrm{R} = \frac{144 \times 62{\cdot}5 \times 30}{(21 \pm 0{\cdot}2) \times 1{\cdot}440 \times 0{\cdot}1} = [89{,}200 \pm 800] \text{ megohms.}$$

Should V vary during the time t, so as to cause error in the result, an average value may be taken. For all practical purposes we may take the mean of the highest and the lowest values $\left[\frac{\mathrm{V}_o + \mathrm{V}_t}{2}\right]$; but if an absolutely exact value is needed it is :—

Average value of V =

$$\frac{\mathrm{V}_o}{1 + \frac{1}{2}\left(\frac{\mathrm{Q}_o - \mathrm{Q}_t}{\mathrm{V}_o\,\mathrm{C}}\right) + \frac{1}{3}\left(\frac{\mathrm{Q}_o - \mathrm{Q}_t}{\mathrm{V}_o\,\mathrm{C}}\right)^2 + \frac{1}{4}\left(\frac{\mathrm{Q}_o - \mathrm{Q}_t}{\mathrm{V}_o\,\mathrm{C}}\right)^3, \text{ \&c.}}$$

In the case of the wire on which these experiments were made, all terms beyond and including the second may be neglected, with an error of less than one-third of the possible error due to irregularities in the readings, for

$$\frac{1}{2}\left(\frac{\mathrm{Q}_o - \mathrm{Q}_t}{\mathrm{V}_o\,\mathrm{C}}\right) = \frac{21 \times 0{\cdot}001}{2 \times 62{\cdot}5 \times 0{\cdot}082} = 0{\cdot}002048.$$

The next term of the series will be 0·000,006. Applying the whole correction R = [89,000 ± 800] megohms.

This method has also been used in testing another sample of a thousand feet of insulated wire, which after being in the water one day had an insulation resistance of about five hundred thousand (500,000) megohms. (The insulation-resistance has since fallen to about one-fifth of that amount. A final determination has not yet been made.) The first method applied to this was a total failure. There was no readable deflection of the galvanometer. On applying my method the deflections were quite large at first and decreased for several hours. After four hours they had fallen to about one-third of the value which they had 20 minutes after the charging began. There was evidently considerable absorption.

In presenting this method, I would call attention to what I consider its chief advantages over the more common methods. In the first place, supposing that the wire has sufficient capacity to admit of the use of the method, we may apply it in any case when the first method (the direct deflection) would fail. The higher the insulation resistance becomes, the more easily is this method applied, for it requires simply that the observations be taken at greater time intervals. Absorption of the charge causes no inconvenience beyond making it necessary that the wire be left charging during a longer time. In the second place, it is far more accurate than either of the other methods; and, when there is added to these the extreme simplicity of the calculations, which are made without recourse to Napierian logarithms, it would seem as though the worth of the method were established.

Laboratory of Physics,
University of Michigan.

LONDON COUNTY COUNCIL.

THE Highways Committee reported as follows:—

SUBWAYS.

We have considered an application from the National Telephone Company to be allowed the same space in the Northumberland Avenue subway as has been accorded to it in other subways. The company is willing to pay for this accommodation a rent of £9 10s. a year, which is in accordance with the scale of charges recently laid down by the council. We see no objection to this, and therefore recommend that permission be given to the National Telephone Company to use a sectional area, equal to 1 square foot, in the Northumberland Avenue subway, upon the same conditions as were attached to the council's consent to the use by the company of other of the council's subways.

An agreement, embodying these conditions, for the use by the company of the subways in Queen Victoria Street, Victoria Embankment, Charing Cross Road, Shaftesbury Avenue, and Northumberland Avenue, and providing for the payment by the company of an aggregate rent of £161 10s. a year in respect thereof, has been prepared by the solicitor; and we recommend that the seal of the council be affixed to this agreement.

USE OF SUBWAYS BY COMPANIES AND OTHERS.

On the 10th of February last we reported upon the reference made to us by the council on the 2nd December, to consider and report upon the advisability of the council applying to Parliament for powers to compel gas, water and other companies to place their pipes, wires, &c., in the subway of Rosebery Avenue, and to enable the council to charge a rent for such user. We then stated that in our opinion any application made on the subject to Parliament should have relation to all the subways of the council, and should not be limited to that in Rosebery Avenue; and we referred to the opposition to such a measure which had on previous occasions been offered by the gas and water companies. Upon a careful reconsideration of the matter, we are of opinion that a further effort should be made by the council to obtain the powers referred to. We accordingly recommend that it be referred to the Parliamentary Committee to prepare a Bill, giving the council power to require that where there are subways in any thoroughfares, gas, water, and other companies shall lay their pipes, wires, &c., in such subways, and shall pay to the council a rent in respect of the user of the subways; such rent to be agreed upon, or, in case of difference, settled by arbitration of the Board of Trade.

ELECTRIC-METER TESTING STATION.

It is necessary, for the testing of meters and for other purposes, that a supply of electric current shall be obtained from the Metropolitan Electric Supply Company to the council's testing station in Cranbourne Street. The company's Mid-London order, under which it supplies the area within which the station is situated, enacts that every owner or occupier of premises requiring a supply of energy, shall serve a notice upon the undertakers, specifying the premises to be supplied, the maximum power required, and the date for the commencement of the supply. We are advised that, in order to comply strictly with the requirements of the order, the council should serve such a notice upon the company. We submit a form of notice which has been prepared by the solicitor, requiring such supply to the electric meter testing station as from 1st July next; and we recommend that the seal of the council be affixed thereto; and that the notice be served upon the Metropolitan Electric Supply Company.

NOTICES UNDER ELECTRIC LIGHTING ORDERS AND ACTS.

The St. James and Pall Mall Electric Lighting Company has asked that in the case of service lines from distributing mains the one month's notice specified in the company's order may not be insisted upon, and that in place thereof the council will accept four days' notice. The council has acceded to similar applications made by some of the other electric lighting companies, and we are of opinion that this also may be acceded to. We recommend that the St. James and Pall Mall Electric Lighting Company be informed that the council will, until it gives notice to the contrary, accept four days' notice (instead of the one month's notice required by the company's order), of the intention to lay service lines from distributing mains already laid; and that the Highways Committee be authorised to deal with such notices on behalf of the council.

We have considered a notice (Registered No. 203), dated 11th May, 1891, from Mr. H. Robinson, on behalf of the Vestry of St. Pancras, under the St. Pancras (Middlesex) Electric Lighting Order, 1883, of intention to lay mains in Osnaburg Street, Hampstead Road, Euston Square, Melton Street, Chester Terrace and Place, Cumberland Place, Outer Circle, Gloucester Terrace, Park Street, and High Street, Camden Town (3 plans, D, E, and F). Some of the streets referred to in the notice are on Crown property and therefore under the control of Her Majesty's Office of Works, and over these the council has no jurisdiction. The proposed works are similar to those approved by the council on the 16th of December last, on the application of the vestry; and, seeing no objection to them, we recommend that the council do approve the works referred to in the notice (Registered No. 203) of the Vestry of St. Pancras, dated 11th May, 1891, under the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883, so far as relates to such thoroughfares as are under the jurisdiction of the council.

We have also considered a notice (Registered No. 204), dated 14th May, 1891, from the Westminster Electric Supply Corporation, of intention to lay mains in Carpenter Street, Mayfair (1 plan, No. 172). There appears to be no objection to the proposed works; and we recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 204), dated 14th May, 1891, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the mains be laid under the footways whenever it is found practicable to do so; and that the covers of the street-boxes to be used shall consist of iron frames filled in with material to suit the paving.

The Notting Hill Electric Lighting Company has given two notices as follows:—May 26th, 1891 (Registered No. 205), of intention to lay mains crossing High Street, Notting Hill, from the north side to No. 47 on the south side (1 plan, No. 42A). May 28th, 1891 (Registered No. 206), of intention to lay mains in Pembridge Square and Place, Westbourne Grove (part of), and Pembridge Villas (part of) (1 plan, No. 28A).

The proposed works are unobjectionable, and we recommend that the sanction of the council be given to the works referred to in the two notices (Registered Nos. 205 and 206), dated May 26th and 28th, 1891, respectively, of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the cover stones of the culvert shall not be less than 2 inches thick; and that where the culvert crosses the carriageway there shall be at least 9 inches thickness of Portland cement concrete above the cover stones of the culvert, in addition to the road material.

Notices, as follows, have been received from the Kensington and Knightsbridge Electric Lighting Company:—May 18th, 1891 (Registered No. 207), of proposed extension of mains in Brompton Road (1 plan, No. 190A). 29th May, 1891 (Registered No. 208), of proposed extension in Thurloe Place (1 plan, No. 192A).

There is no objection to these works, and we recommend that the sanction of the council be given to the works referred to in the two notices (Registered Nos. 207 and 208), dated May 18th, 1891, and 29th May, 1891, respectively, of the Kensington and Knightsbridge Electric Lighting Company.

We have also considered a notice (registered No. 209), dated June 2nd, 1891, from the Metropolitan Electric Supply Company, of intention to lay mains in Edgware Road and Place, Hall Place, Church Street, Paddington Green, Harrow Road, Victoria Street, Albert Street, Green Street, North and South Wharf Roads, Praed Street, Cambridge Place, Bouverie Street, Junction Place, Sale Street, Market Street, Star Street, Upper Southwick Street North, Grand Junction Road, Upper Porchester Street, Tichborne Street, and Burwood Place (1 plan, No. 829). The proposed works are similar to those of this company previously approved by the council, and we recommend that the sanction of the council be given to the works referred to in the notice (registered No. 209) of the Metropolitan Electric Supply Company, dated June 2nd, 1891, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be enclosed in iron pipes or efficient casing, and be laid under the footways wherever it is found practicable to do so; that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable; and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth.

We have also to report the receipt of a notice, dated May 15th, 1891, from the London Electric Supply Corporation, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid, of intention to lay a service line to No. 25, Buckingham Palace Road.

LEGAL.

Nickel Plating and Electrotyping.—In the Court of Session, Edinburgh, on Friday last, June 5th, Lord Kyllachy had before him an action by John Denby, stereotyper and electrotyper, 4, Swinton Row, Edinburgh, against Ernest Scott and Mountain, Limited, engineers, Close Works, Newcastle-upon-Tyne, for £500 damages. The pursuer is a stereotyper and electrotyper in Edinburgh, and the defenders are marine, electrical, and general engineers in Newcastle-upon-Tyne. Up to the end of the year 1890 or the beginning of 1891 the defenders' business was carried on under the name of Ernest Scott & Co., and thereafter under the name of Ernest Scott and Mountain, Limited, and Ernest Scott & Mountain have accepted the position and liabilities of Ernest Scott & Co. Ernest Scott & Co. had exhibits of their electrical manufactures, and in particular of dynamo machines, at the Edinburgh Exhibition of 1890, and the pursuer made enquiries of their attendant in charge as to their ability to furnish a dynamo suitable for use in his business of electrotyping. On being assured that they were able to furnish such a machine, the pursuer, in June, 1890, entered into a correspondence with Ernest Scott & Co., informing them that he was in business as an electrotyper, indicating the extent of his business requirements, and enquiring whether they could furnish him with a dynamo adapted to these requirements. In order to be adapted to the requirements of electrotyping it is essential that a dynamo shall be capable of depositing the necessary coating of copper, having a smooth, tough surface, on one or more moulds simultaneously, in the course of from three to five hours. Some correspondence passed between the pursuer and Ernest Scott & Co., with the result that that firm undertook to furnish the pursuer with the article required at the price of £55, payable six months after delivery. The article was described by them as being their No. 5 plating dynamo. The dynamo was delivered in the middle of September, 1890. The machine was expressly sold for the specified and particular purpose of being used in the pursuer's business as an electrotyper. After the contract was completed and the dynamo was ready for delivery, Ernest Scott & Co. requested the pursuer to enter into an ancillary memorandum of agreement, whereby in respect that the purchase price of £55 was not to be payable till six months from the delivery of the dynamo, it was agreed that the company should remain owners of the machine until full payment of the price with interest, charges and expenses, and any other sums that might be due to the company. Accordingly the pursuer entered into this ancillary agreement. On receipt of the dynamo the pursuer had it fitted up in his workshop in a suitable manner, and proceeded to use it for the purpose of his business. The machine, however, failed to do what it ought to have been able to do, viz., to deposit copper properly on the moulds prepared by the pursuer. The pursuer repeatedly wrote to the defenders complaining of the inability of the dynamo machine to make the deposit. In answer to his complaints they took up the position that the machine was perfect, but that the pursuer had not the skill necessary for its proper manipulation. In consequence of this the pursuer, in deference to the defenders' assertion of superior knowledge, refrained from immediately rejecting the machine, and did everything in his power to discover and remedy the supposed defect in the manipulation. On 8th November, 1890, the defenders wrote the pursuer a letter, in which they [illegible]: "When you ordered the dynamo from us we were under the impression that you might probably require the machine for nickel-plating as well as copper depositing. We therefore constructed it in such a manner that it would be suitable for both purposes, as when plating nickel it is necessary to have an E.M.F. of about 6 volts to get the metal to adhere firmly at the commencement." They conceded that the deposit at that time would not be satisfactory, and to make it so they suggested that the pursuer should purchase from them a resistance coil, which would, as they asserted, control the power of the machine, and have the effect of making it deposit properly. The pursuer, as the defenders well knew, had never given them the slightest reason to suppose that he wanted the machine for nickel plating, but being anxious to do what he could to get the machine to work well, obtained the resistance coil from the defenders, and tried various experiments at the defenders' suggestion to render the dynamo efficient as an electrotyping machine, but without success. Thereafter he discovered that the machine could not be made suitable for use in electrotyping, that its being adapted for nickel-plating was, as the defenders must have been aware, absolutely fatal to its use in electrotyping, and that the defenders' expedient of furnishing a resistance coil involved an admission on their part of knowledge that the machine was not adapted for electrotyping. He therefore called upon the defenders to remove it, and this they did on 14th April, 1891. The dynamo is defective and unfit for the specified and particular purpose for which it was furnished in respect that—(1) It was constructed both for the purpose of nickel-plating and electrotyping. A dynamo machine constructed for nickel-plating is not suited for electrotyping. (2) The dynamo furnished a current of too high an electromotive force for electrotyping, and caused the deposit of copper to take a granular form instead of presenting a smooth tough surface. (3) It could not produce a satisfactory electrotype sooner than twelve or fourteen hours, whereas it should produce one within three to five hours, according to the quantity of moulds in the bath. In consequence of the dynamo being defective and unfit for its purpose, the pursuer has suffered great loss and damage. Just at the time when he ordered the machine the pursuer had secured a very large and lucrative order for electrotypes, and had the machine been even approximately conforming to contract the pursuer would have easily been able to supplement the order, and to make a large profit thereby. He was, however, through the breakdown of the dynamo, unable to execute the order, and the work was taken from him. Several of his customers had left him on account of the bad work he produced in consequence of his using the dynamo; to others he has had to give discounts from his accounts, also on account of the bad workmanship. He spent a great deal of time and money in endeavouring to get the machine to work properly, and employed his engine at the work also at considerable expense. Further, his business has sustained such loss and damage that it will take a very considerable time before it can regain its former position. The pursuer estimates his loss on the above grounds at £500.

In answer to these statements, the defenders say that at the end of December, 1890, they purchased the business carried on at Close Works, Newcastle, by Ernest Scott & Co., of which firm Mr. Ernest Scott was the sole partner, and are now carrying on the same. The defenders admit that Ernest Scott & Co. had an exhibit of their manufactures, including dynamo machines, at the Edinburgh Exhibition of 1890, and that the pursuer made some enquiries of E. S. Lowes, then attendant in charge of the exhibit, as to dynamos for electrotyping purposes. The attendant gave him a price list, and said he could give Ernest Scott & Co. full particulars of what he wanted. The defenders further admit that the firm of Ernest Scott & Co., on pursuer's order, supplied him with a No. 5 plating dynamo on September 18th, 1890, on the hire-purchase system, at the hire of £55, payable six months after delivery, the dynamo to remain the firm's property until paid for. The defenders say the machine was not sold by Ernest Scott & Co. for any specified and particular purpose, nor did pursuer state to them the nature of his business or its requirements. The defenders never entered into any contract with the pursuer, or adopted any contract or assumed any responsibility or liability in respect of any contract entered into with him. The defenders believe that the dynamo was not suitably fitted up, and the engine to drive it and the bath were not suitably fitted and arranged. The dynamo required to be fitted up with a resistance coil, and to have a resistance inserted between it and the bath. The pursuer ought also to have had a voltmeter and an ampèremeter, to measure the pressure and the current respectively. The pursuer's gas engine ran irregularly, its speed increasing at the time of the explosion of the gas, and gradually decreasing until the next explosion, with the result that the current was irregular, and the deposit consequently granulated. The dynamo ought to have been fitted up with a flywheel to ensure steady running, and this was explained to the pursuer, but he said he could not go to the expense. He ought also to have had the necessary instruments to ascertain the density and temperature of the solution in the bath, and to keep the solution agitated. If he failed to obtain a satisfactory deposit, it was entirely due to his lack of knowledge, his want of skill in manipulation, and to the absence of the necessary instruments. The machine supplied by Ernest Scott & Co. was an excellent one for its purpose, and was in perfect order. The defenders admit that the pursuer got from them a resistance coil. They further admit that the pursuer called on the defenders to remove the machine, and that they did so on 14th April, 1891. This was in consequence of a threat by the pursuer's agent, that unless it was removed in three days he would present a petition to the sheriff for warrant to remove and sell the machine by public auction, and under an express agreement with him that the removal of the machine was without prejudice to the rights of parties. The threat was a device on the part of the pursuer's agent to enable him to found jurisdiction in Scotland against the defenders by arresting the machine, which he did immediately on its removal from the pursuer's premises. The defenders plead that they never entered into the contract with the pursuer, for the alleged breach of which he claims damages, and never adopted the same or assumed liability in respect thereof.

Lord KYLLACHY sent the case to the roll for discussion and proof.

The New Telephone Company.—Mr. Higgins, Q.C.' on Saturday, applied to Mr. Justice North, under Section 29 of the Companies Act, 1862, for an order staying the proceedings in the winding up of this company. He said it was an application not often made, but he did not think there was any difficulty about it, the liquidation in this case being under the supervision of the court. The applicants were two contributories, and the liquidator was the respondent. The whole of the debts proved amounted to £5,223 8s. 3d., the principal debts being £4,000 in respect of certain patents, due to Prof. Silvanus Thompson and others, but these had now been released, and Prof. Thompson was one of the two petitioners. This only left £1,173 17s. 7d., which would be paid in full, there being one asset, and, in fact, the only one, which might be of considerable value if the company went on, but which would be utterly worthless if the company were wound up, as it consisted of a license from a public body. All the shareholders but four had already signified their consent to the application. One thousand pounds had already been provided for paying the debts, but, of course, the small balance would have to be found so that the creditors might be satisfied, and he should ask that the order be made not to be drawn up until an affidavit was produced by the liquidator showing that all the debts had been discharged.

His LORDSHIP said he would make the order when such an affidavit was produced. The petition need not be mentioned again.

NOTES.

Cricket.—A cricket club has been formed by the *employés* of Messrs. Laing, Wharton and Down. Challenges are invited from any clubs in the electrical trades.

New Swiss Electric Railway.—An electric railway on the overhead system has just been inaugurated between Sissach and Gelterkind, in the canton of Basle. The power is obtained from a fall of water.

Liverpool Electric Lighting.—At the monthly meeting of the Liverpool City Council, held on the 3rd inst. at the Town Hall, the Mayor (Mr. Joseph B. Morgan) presiding, the Watch Committee brought forward a scale of charges for testing lines and mains recommended by them to be made under the Liverpool Electric Lighting Order, 1889, and this schedule was passed by the council without discussion, on the motion of Mr. H. H. Hornby, the chairman of the Watch Committee.

Mill Lighting in China.—Mr. G. A. Woods, writing from Shanghai, says "the first cotton spinning and weaving mill erected in China is to be lighted throughout with incandescent lamps, the number used being 1,200. The order was placed with an American firm, and after their supplying their usual quality of material, it was promptly condemned by the fire office. The order was then placed in the hands of Mr. James Price, engineer to the new Shanghai Electric Company, who, if I am correctly informed, has placed the order with Messrs. Crompton and Co., of Chelmsford and London."

Liverpool Electric Laboratory.—At the meeting of the Fire, Police and Lighting sub-committee at the municipal offices, Liverpool, on the 1st inst., the city engineer further reported as to assistants to the electric inspector, Mr. Yeaman, and suggested that Mr. T. H. Tarleton, of Waterloo, be permitted to remain in the electric laboratory of the city engineer's department as a pupil during the pleasure of the committee. This was unanimously agreed to after Mr. Tarleton had been called before the committee. An item of £38 1s. 7d. for further fittings and equipments to the laboratory was then passed without discussion, and the committee proceeded to other business.

The Paris Telephone Service.—If the statements made by the *Independance Belge* are correct, there is certainly room for improvement in the working and management of the Paris telephone service. Since the opening of the line this Brussels paper has received a portion of its London correspondence by telephone *viâ* Paris, but during the last two or three weeks there have been frequent irregularities in its communications from London. This is mainly attributed to the action of the English postal authorities, who allow stockbrokers to monopolise the line to the detriment of the press, and "contrary to the regulations by virtue of which communication must be granted successively to each of the persons who desire it."

Lightning Shocks in Belgium.—M. F. Evrard, chief engineer and director of the telegraph service, and M. L. Lambotte, telegraphic engineer, have just published a sixth paper on their observations as to lightning shocks in Belgium. One of the conclusions at which they arrive is that the network of telephone and telegraph wires considerably decrease the dangers of lightning in towns served by them, and that the supports and buttresses put up by the State constitute effective lightning conductors for the buildings on which they are placed. The most effective lightning conductor, according to Messrs. Evrard and Lambotte, is that invented by Melsens. On this subject we may mention that Article 88 of the Budget of the province of Brabant for 1891 provides a sum of 10,000 francs for the placing of lightning conductors on communal buildings, and as a number of these buildings are not provided with protective apparatus, a number of lives will probably be saved each year by this determination.

Society of Arts.—Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of medals for subjects, in the first instance, relating to the prevention of fire. A Society's gold medal, or £20, is now offered for the best invention having for its object the prevention or extinction of fires in theatres or other places of public amusement. In cases were the invention is in actual use, reference should be made to places where it could be inspected. A full description of the invention, accompanied by such drawings or models as are necessary for its elucidation, must be sent in on or before the 31st December, 1891, to the Secretary of the Society of Arts, John Street, Adelphi, London. The council reserve the right of withholding the prize in case there is nothing in their opinion deserving the award, or sufficiently complying with the conditions, sent in for competition.

Electrical Progress in the North.—Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, have, we understand, secured the contract for the lighting for the Bolton Technical School, the installation to consist of two of their improved type Tyne compound-wound dynamos with fast and loose pulleys and heavy turned flywheels, each machine being capable of running, if required, up to 200 16-C.P. lamps; the installation itself will consist of 220 16-C.P. lamps with fittings. The firm have also the contract in hand for the lighting of the Armagh Spinning Company's Mills in Armagh, Ireland, the installation consisting of one Tyne compound-wound dynamo for 400 16-C.P. lamps and 380 incandescent lamps and fittings. They are also lighting Mr. Walter Jones's house at Blakemere, Cheshire, throughout; this installation will be very complete, the motive power consisting of a horizontal steam engine and boiler with automatic expansion gear and Tyne dynamo for 90 16-C.P. lamps, accumulators for 80 lamps and 110 lamps throughout the house, stables, &c. The same firm are lighting Messrs. Edwards Dry Docks at South Shields, the installation which they are now erecting being specially designed to enable the repairs of oil ships to be carried out with safety, it not being possible to use oil lamps in holds where petroleum vapour exists, on account of the risk of explosion. In addition to the above work, we understand that Messrs. Ernest Scott and Mountain, Limited, are extremely busy in their electrical department, having just completed a large hotel in Huddersfield, and also having in hand three large installations in progress in Scotland.

The Proprietor of the English Language.—The proprietor of the *Electrical World*, W. J. Johnston, has seen fit to bring a suit against us (*Electrical Age*) for exercising our right to change our title from the *Electric Age* to the *Electrical Age*. Mr. Johnston seems to claim a proprietorship of the English language. He fancies that he has an inalienable right to the word "Electrical," and that any person using it commits a wrong and ought to pay damages to his paper. When he was invested with this sovereignty over the English tongue he does not inform us. Fortunately for our esteemed contemporaries, the *Electrical Engineer*, the *Electrical Review*, the *Electrical Industries*, the *Electrical North West* and the *Electrical Enterprise*, we resisted this remarkable claim, and in an action brought by Mr. Johnston against us, we have been sustained by the courts. The *Electrical World*, in its suit against us for an injunction, made a motion to enjoin us before Hon. George P. Andrews of the Supreme Court, and Judge Andrews not only denied their motion, but wrote the following opinion :—"It is certainly very doubtful whether the plaintiff will succeed in this action, and I do not think an injunction should be granted before the trial. Motion denied, with $10 costs to defendant to abide the event of the action." Not content with this, Mr. Johnston appealed to the General Term of three judges, who sustained the Court below and also denied his motion with costs. The Appellate Court deemed his complaint so little worthy of attention, that they did not deign to write an opinion upon so contemptible an insinuation.

Correction.—In the conclusion of the article on the Electrical Works of the Place Clichy in last week's issue of the REVIEW, for $+ 2 \times 4 = 0$, p. 725, read $+ 2 \times 0 = 0$.

Engine Cranks.—The *English Mechanic* last week stated that a patent had been obtained by Mr. H. E. Walter (8720, 1890) for an invention by which the speed of trains is reduced by the reaction produced by causing Foucault currents to be induced in the rail by magnets carried by the train with their poles in proximity to the rail. The two poles are in a line parallel with the rail, and are so set that magnetic lines of force pass through the rail from one magnet to the other. The magnets are excited by storage batteries or a dynamo on the train. We have been under the impression that if anything more was wanted with regard to the speed of trains, it was an increase, if it could be safely accomplished and would prove commercially advantageous. But that there can be found a man in these days of enlightenment who seriously believes that he is going to slacken the velocity of a train by the means above described, passeth all understanding.

Faraday's Magneto-optic Phenomenon.—Some months ago an American physicist, Mr. Sheldon, showed that the magneto-optic phenomenon of Faraday, namely, the electromagnetic rotation of the plane of polarisation of light was reversible. A luminous ray polarised rectilinearly, and of which the plane of polarisation is submitted to a rapid oscillation gives rise to in certain substances an oscillating magnetic field, which will produce a current in a coil traversed by the luminous ray. The application of the telephone has enabled the existence of this current to be recognised, but its intensity is naturally very feeble. Professor Mais has been describing this new phenomenon to the Electro-technical Society at Vienna. He has endeavoured to see whether the optic theories enable it to be demonstrated *a priori*, or whether the fact may be taken for granted, as well as the theory which it gives rise to. According to the Professor the theory elaborated by Sellmayer, Helmholtz, &c., in which the existence of dyssymetric friction forces in the ether is admitted in order to explain the phenomenon of circular polarisation, is susceptible also of furnishing a simple and natural explanation of the new phenomenon. Professor Mais has been entirely won over to the electro-magnetic theory, of which he regards Sheldon's new phenomenon as a strong confirmation.

The Use of Lead Amalgam in Accumulators.—Mons. Nézereau has recently been again directing his attention to the subject of accumulators. It will be remembered that his earliest work referred to the use of juxtaposed amalgams. The active material of this modified accumulator consisted of spongy lead which was obtained by eliminating mercury from an amalgam of lead (Hg : Pb :: 1 : 2); this was fused and the cold crystalline mass was then powdered and compressed into a grating set in a frame and after being hardened by immersion in dilute sulphuric acid and subsequent exposure to the air the prepared plates were then ready for the action of the forming current. These early accumulators of Nézereau, it may be remembered, had a capacity reaching as high as 25 ampère hours per kilogramme of plates, but they were costly to make. Nézereau has observed that in the case of accumulators in which spongy lead is the active material, this material in the positive electrodes, especially in the neighbourhood of the supports, is very rapidly acted upon chemically, moreover the agglomerated materials do not form with the metal a sufficiently intimate and conducting layer. He finds that it is only necessary to cover the polar surfaces with a spongy layer of 4 millimetres thickness, for this distance appears to be the limit of the destructive action of the charging current. He still considers that the most efficacious conditions would be realised by employing amalgams of lead but he recognises that there are very great practical difficulties to be contended with.

Steamship Lighting.—The Union Steamship Company have recently launched from Denny & Co.'s yard, at Dumbarton, a new R. M. steamer, named *Scot*. This is without doubt the finest steamship yet built for the Cape trade. The ship is lighted throughout by electricity, and the ventilation, which is effected by electric fans, is all that could possibly be desired.

Very Much a Lightning Stroke.—A correspondent writing to the editor of the *Scientific American* says that on the evening of April 25th last, during a violent thunder storm, the lightning struck the lightning rod on a dwelling house, followed the rod until it came to a defective insulator, then entered the house, striking a friend named Mr. Roode about half an inch back of the ear and burning its way the entire length of his body, then through a wool mattress, splitting a hard maple bedstead, afterward passing through various parts of the house until it reached the water pipe. After four hours of skilful work Mr. Roode regained consciousness and is on the road to recovery. His body is now so heavily charged with electricity that he can impart to any one taking him by the hand an electric shock equal to that received from a powerful battery.

The Engineer of the Future.—Since the introduction of electricity into common, matter of fact, every-day life, the demands for economical power, says W. D. Tomlin in *Practical Electricity*, have pressed hard on the brain of the constructing engineer. Some men have boasted that steam as a motive power is doomed, and its days are numbered; that electricity is the coming power. Perhaps it is; but the recent developments tend toward the employment of stupendous steam power to produce electricity; simply because electricity can be distributed at a far less percentage of loss than any other motor. You cannot carry steam 200 feet without considerable condensation, but you can distribute electricity nearly 200 miles, and at the point of distribution your ampères will be almost initial. You cannot transmit horse-power by gearing, rope, belting, or otherwise without a loss of power by slippage, friction, or kindred causes; but you can distribute electricity through 10 miles of lines, and give to each renter his pound of electricity through a small dynamo, just in proportion as his contract calls for. Young men, I can assure you of one thing: Go into the city and ask for employment as engineer; almost the first thing you are asked is, "Dou you know anything about taking care of a dynamo or electric plant?" "No." "Well, we don't want you. Good morning!" It has become almost a necessity that an engineer should know something of electricity if he expects to secure employment. Look through any prominent engineering journal, and you will find from a dozen to fifteen Corliss valve gear motions. An adjunct of the Corliss engine is the indicator; and the time is rapidly coming to us when an engineer's education will be incomplete who cannot use an indicator and adjust the valves of his engine. What the stethescope is to the doctor, the indicator is to the engineer. Both the professions are thus enabled to examine the breathing organs of the patient. The use of an indicator, while reflecting credit on the engineer who can use it, is a possible benefit to the steam user and owner, because thereby the coal pile is considered. The owner gets the full benefit of every pound of fuel saved, the saving being a *bonâ fide* transaction, often affecting the balance of a set of books from a debit to the credit account. The time is close at hand, Mr. Tomlin predicts, when an indicator will be a part of the engine room outfit, and a daily engine log be as carefully kept as the double entry set of books in the general office.

Cable Items.—The ss. *Silvertown* is taking on board cable for the Western and Brazilian Telegraph Company, and she is expected to leave the Thames next week. The ss. *Duchess of Marlborough* will leave Siemens' works with cable for the West India and Panama Company to-morrow morning. The cable companies generally seem now to be fairly busy with orders for home and abroad.

Electrical Exhibition at Taunton.—The Taunton Electric Lighting Company has adopted a suggestion of Mr. Massingham (its managing director), and intends shortly to open in that town an electrical exhibition, for the purpose of demonstrating the many useful purposes to which electrical power can be put. It is intended to cover in the large courtyard of the electric lighting depôt, and to fit up the space with rooms, in order to illustrate different methods of domestic lighting. These apartments will be fitted up in sumptuous style, and will be lighted throughout by incandescent lamps, with all descriptions of fittings, so that those who are contemplating the introduction of the electric light into their houses may see how cheaply or how expensively they can do it. Various examples of electric motors will be shown, and it is intended to run an electrical omnibus to and from the railway station for a short period, and to exhibit an electrical launch on the river.

Electrical Sub-Stations.—Though most electrical engineers have come to the conclusion that house transformers are a mistake, there is a difference of opinion as to what a sub-station should be. From an assumption that ordinary small transformers give efficiencies approximating to 98 per cent., there has been an oscillation over to the opinion that even large transformers are so bad that they must be banked. We describe in another column a most ingenious apparatus for cutting transformers in and out. Such an apparatus may be necessary with existing transformers, but if half the brain-work involved in designing it were devoted to the study of transformers, banking, with its attendant evils, would be unnecessary. In designing central stations very serious mistakes may be made by adopting sub-stations of this sort. There can be no doubt that in a very short time even closed circuit transformers will be made so efficient that cutting them out of circuit during the day will not be worth while, and engineers will find they have marred their designs to meet an obsolete requirement. They will then find that they have rents to pay, complicated mechanism to look after, and that the independent feeder system is inapplicable unless they have an attendant at the sub-station. There can be no advantage in banking transformers, and a transformer at the end of a high-pressure feeder, placed in oil in the ground, is capable of controlling the lighting arrangements of a whole town, whatever its size, by means of feeders and networks.—*Industries.*

Extinguishing Fires by Electricity.—A correspondent writes:—"An improved plan of extinguishing fires by employing a water system governed by electricity has been announced. The inventor is H. Lufkin, and if it is developed and perfected, as there is reason to believe that it will be, this plan will doubtless soon become popular, especially amongst those classes of trade which involve large shops, warehouses, mills, &c. The systems of automatic sprinkling which are in vogue are open to some objections which are obvious to those who have ever had the necessity of testing them in those circumstances for which they are specially designed. Lufkin proposes to introduce an important modification which is calculated to remove the more serious of these objections. His modification comprises the use of a motor and pump and a complete system of "sprinkler" pipes. These pipes are suitably arranged in every part of the building which it is desired to protect. There is in connection with this system a large number of "push buttons," arranged so as to be as handy as possible, and these start the motor and pump and open any valves which may be required for extinguishing the fire. It is believed that the instantaneous control of large masses of water thus gained by adopting the system, together with the power to *localise* the flow of the water will materially increase the ease and certainty with which fires may be extinguished. So much has been said in certain quarters lately with regard to fires having been started by faulty electric light wires that an invention like the above, in which electricity may be employed for rapidly extinguishing fire, is certain to be warmly received by all those who are interested in dispelling prejudice and correcting erroneous opinion concerning the safety of the electric light.

Electric Traction in Breslau.—By the intervention of the Under State Secretary von Stephan, the objections of the postal authorities to the building of an electric railway in Breslau have been removed.

The Elmore Copper-Depositing Company's Schemes.—We have received from Mr. A. Watt a very lengthy reply to Mr. Peck's letter in our last number, but it came to hand too late for this issue.

Lineman Killed.—Last Friday William Bruce, a telegraph lineman, formerly residing in New City Road, Glasgow, was run over and killed on the Wemyss Bay line near the junction with that railway and the Caledonian lines at the west-end of Port-Glasgow. Deceased, along with several other workmen, was employed laying a telegraph wire from Port-Glasgow to Upper Greenock.

The United Telephone Company of the River Plate, Limited.—Notice is given in the London *Gazette* that a general meeting of the members of the above-named company will be held at 53, New Broad Street, in the City of London, on the 1st day of July, 1891, at 12 o'clock, noon, for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted, and the property of the company disposed of, and of hearing any explanation that may be given by the liquidators; and also of determining, by extraordinary resolution, the manner in which the books, accounts, and documents of the company, and of the liquidators thereof, shall be disposed of.

Wonderful Effects of the Kidder Battery.—When we noticed this heading in an American exchange we, for the moment, imagined the name "Kidder" to have been used in the manner of the slang English vernacular for an individual who makes it his business to mislead others; but the following extracts will show how completely unjustifiable were our suspicions:—D. B. Hillis, M.D., writes:—"I have had and tried a number of other makes of batteries, none of which did the good *healing* service of the Jerome Kidder." S. E. Morrill, M.D., who has written a treatise of "Practical Instructions in the Medical and Surgical Uses of Electricity," writes:—"I am treating cancer successfully, and they cannot *(sic)* be cured, only with the Kidder battery."

Electric Launches on the Thames.—Two new electric boats were launched on the Thames on Monday afternoon at Strand-on-the-Green, Chiswick, by Messrs. Woodhouse and Rawson United, Limited. The larger one of the two is called the *Glowworm*. It is 53 feet long with 7 feet 2 inches beam, has a draught of 2 feet 6 inches, and displacement of $5\frac{3}{4}$ tons. The accumulators run under the seats throughout, and the motor is aft. She will carry 40 passengers, make about nine miles an hour, is lighted as well as propelled by electricity, and carries a search light. The other boat, the *Myiomi*, is 35 feet long, with 5 feet 6 inches beam, and 18 inches draught, and a displacement of $3\frac{1}{4}$ tons, and is built for Captain Homfray, of the Horse Guards. She is constructed of mild steel, with teak fittings; her electric arrangements are similar to those of the *Glowworm*, but there is no search light.

Telephonic.—At the invitation of the National Association of Colliery Managers, Mr. H. Erskine Muirhead, Glasgow, recently gave an exhibition of a portable form of French telephone to show its adaptability to underground control of collieries by communications to and from the pithead. A further trial under actual conditions will take place between the Binniehill Colliery, Slammannan, and Arniston Colliery, Gorebridge.

Electricity Meters.—Messrs. Richard Frères have just issued from their London house an English edition of their Meter Catalogue and price list. It contains good illustrated descriptions of their many indicating and self-recording instruments in their applications to the electrical, meteorological and other sciences. It is well worthy of perusal by those interested in such subjects.

Joined the Majority.—Mr. Alfred Roger Dawson (of Messrs. Rashleigh, Phipps and Dawson) was married on Thursday at the parish church, Streatham. Last week the entire staff waited upon Mr. Dawson and presented him with a magnificent marble clock and inscribed vellum.

Centenary of the Birth of Michael Faraday.—H.R.H. The Prince of Wales has fixed 4 o'clock on Wednesday, the 17th June, for the delivery by Lord Rayleigh of the first of the two lectures at the Royal Institution in connection with this centenary, and Friday evening, the 26th June, at 9 o'clock, has been appointed for the second of these lectures, which will be given by Prof. Dewar.

The Elmore Companies.—Some correspondents have kindly sent us copies of circulars which they have received containing extracts from the article on the Elmore companies in the *Financial News* upon which we commented last week. As our correspondents are not shareholders in any of the companies, we presume that a wider circulation than that of the *Financial News* is desired for the "information" it conveyed.

Messrs. Mix and Genest.—The report of 1890 of this telephone and telegraph company proposes a dividend of 5 per cent. as against 9 per cent. in the previous year. The diminished rate of dividend is attributed to strikes, higher wages, and reduction in prices for foreign orders, which, although more considerable than in the previous year, were less remunerative, owing to the lower prices obtained due to greater competition. More favourable results are expected for the current year.

The Royal Society.—The following papers were to be read yesterday:—W. Crookes, F.R.S.: "On Electrical Evaporation." G. H. Robertson: "A Study of the Planté Lead-Sulphuric Acid-Lead Peroxide Cell, from a Chemical Standpoint. Part I." Prof. Armstrong, F.R.S., and G. H. Robertson: "Part II. A discussion of the Chemical Changes occurring in the Cell." H. Wilde, F.R.S.: "On the Influence of Temperature upon the Magnetisation of Iron and other Magnetic Substances."

The Sydney Harbour Torpedo Accident.—The inquiry into the recent torpedo disaster in Sydney Harbour has resulted in the finding that Lieut. Hammand and Corporal McKee, two of the men who lost their lives on the occasion, were solely to blame for the accident, the one for attaching a wrong connection, and the other for transmitting a current from the dynamo without making perfectly certain that the cables and earthplates were without doubt in their proper positions.

Submarine Cables of the World.—Respecting a note in last week's issue, a correspondent writes: "Is not the *Journal Télégraphique* wrong in its statistics concerning cables and cable fleet? It credits 'Sweden' with one company and twenty-two cables. This should, doubtless, be 'Denmark,' as it evidently means the cables of the 'Store Nordiske' (Great Northern Company of Copenhagen). This company has two steamers, but they are not included in the cable fleet unless the Berne office think they belong to English companies, and has put them under that head. What about the Persian Gulf steamer? That appears to be left out altogether as the English Government has two vessels in the United Kingdom.

A New Plating Process.—The London Metallurgical Company has recently brought out a new plating process which they call "Arcas" plating, the object being to coat the baser metals with the nobler by electrolysis, so as to prevent their tarnishing and corroding. The new process provides a metallic coating which is not readily discolourable when subjected to tarnishing influences, and not easily affected by acids. This coating can be deposited to any required thickness in an adhesive form, and will not crack or peel off; it is as hard as nickel, but far more elastic, and not porous. The treatment of the silver does not affect the colours of the precious metal, and its prime cost is the same as silver ordinarily electro-deposited; but as it requires less cleaning and no preparation (such as plate powder), and being harder, a comparatively thin coating will last much longer than a thicker coating of silver, thus in the long run being cheaper. The company are showing at No. 4,009, Howe Gallery, Royal Naval Exhibition, a yacht's cabin, the metal fittings of which are plated by their new process, it being especially suitable for resisting the tarnishing and corroding influence of the sea air and water, enabling the fittings of a yacht being kept bright without that difficulty experienced at present with plated articles on board. Chandeliers can be plated by this method, and will resist the heat for longer than at present. It can be used with great advantages in dentistry, not only for instruments, but for mouth-plates, &c., bicycles, harness fittings, public bar fittings; in fact, there is hardly a branch of the metal trade which it will not touch. If the statements of the inventors of the new process are correct, there is a hopeful future before this method of plating, as the solid metal itself soon turns black in the atmosphere of a town.

NEW COMPANIES REGISTERED.

Commercial Contract Corporation, Limited.—Capital, £50,000 divided into 49,000 ordinary and 1,000 founder's shares of £1 each. Objects: to adopt and carry into effect an agreement dated the 30th May, 1891, made between the Commercial Contract Corporation, Limited (a company incorporated on the 3rd January, 1890 and referred to as "the old company,") and O. Friederici and A. H. S. Daniell, its liquidators, of the one part, and T. Lund for the company of the other part; to carry on the business of the old company, to manufacture and deal in any machinery or apparatus for the production and supply of steam, water, electric, magnetic, or other motive power, and to construct, equip and work railways, tramways, canals, mines, gas, water, electric, magnetic, or other works. Signatories (with one share each), G. F. Griffin, 7, Mandeville Place, W.; J. J. Dale, 13, Augustus Road, Hammersmith; W. H. Ball, 58, Lombard Street, E.C.; E. C. Finch-Dawson, 58, Lombard Street, E.C.; A. H. S. Daniell, 58, Lombard Street, E.C.; T. Lund, 21, St. Charles Square, W; O. Friederici, "Oncot," Muswell Hill, N. The number of directors is not to be less than 3 nor more than 5, the first to be nominated by the subscribers. Qualification £100. Remuneration, £300 per annum, divided between them. Registered on the 2nd inst. by Jacobs and Weldon, solicitors to the company, 16, St. Helen's Place, E.C.

Albert Electric Lighting Company, Limited.—Capital, £10,000 in £5 shares. Objects: to carry on the business of electricians, mechanical engineers, and manufacturers of and workers and dealers in electricity, motive power, and light; to produce and accumulate electricity and electromotive force; to supply the same for lighting and motive purposes; to contract for lighting streets, public places and buildings, houses, mines, ships, lighthouses, &c., by electricity; and to acquire the right to use, manufacture, and put up telephones, telegraphs, phonographs, and all electric apparatus. Signatories (with one share each): F. Healy, 130, Packington Street, Islington, N; B. Farrall, 36, Croydon Road, Plaistow; W. M. Shotter, 82, Etta Street, Deptford; F. H. Greenslade, 54, Friendly Street, Deptford; H. B. Hamlyn, 133, Algernon Road, Lewisham; G. B. Gates, 12, Jerningham Road, Hatcham; J. Fleming, 6, Girdlestone Road, Highgate Hill. The number of directors is not to be less than three nor more than nine, the first to be appointed by the subscribers; qualification, 10 shares; remuneration, none unless 7 per cent. is paid, and when such is paid 40 per cent. of remaining profits. Registered on the 2nd inst. by Bonner, Wright, Thompson & Co., 165, Fenchurch Street, E.C. Office: 12, Suffolk House, Lawrence Pountney Lane, E.C.

Farmers' and Cleveland Dairies Company, Limited.—Capital, £50,000 in £1 shares. Objects: to acquire and undertake the business of the Farmers' and Cleveland Dairies Company, Limited, on the terms of an agreement referred to in clause 3 of the articles; and to carry on all or any of the following businesses:—Farmers, dairymen, butchers, cattle dealers, bakers, tobacconists, grocers, dealers in farm implements, mechanical and electrical engineers, electro-platers, dealers in and hangers and fitters of electric and other bells and apparatus, &c. Signatories (with 1 share each): J. J. Arrow, 180, Evering Road, Upper Clapton; D. Humphrey, Acklam, near Middlesborough; R. Lonsdale, Rayleigh House, Rayleigh; C. Middleton, Marton, near Middlesborough; W. V. Prior, The Park, Highgate; J. Waterhouse, 54, Colfe Road, Forest Hill; L. Watson, 4, Park Road, Middlesborough. The number of directors is not to be less than three nor more than seven, the first being the above subscribers. Qualification, 200 shares. Remuneration, 40 guineas each per annum and one guinea per meeting attended. Registered on the 3rd June by H. D. Boosh, 67, Lincoln's Inn Fields, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Kensington and Knightsbridge Electric Lighting Company, Limited.—On the 20th ult. a notice of an increase in the registered capital was filed. The capital, which was £300,000, has been increased to £350,000. The annual return, made up to the 18th ult., was filed on the 23rd ult. The nominal capital is £300,000 divided into 50,000 ordinary, and 10,000 preference shares of £5 each. 15,000 ordinary and 9,590 preference shares have been taken up, upon all of which the full amount has been called. The calls paid amount to £107,550, considered as paid to £15,000, and unpaid to £400. Office, 148, Brompton Road, S.W.

Metropolitan Electric Supply Company, Limited.—The annual return of this company, made up to the 13th ult., was filed on the 22nd ult. The nominal capital is £500,000 divided into 49,900 ordinary and 100 founders' shares of £10 each; 45,932 ordinary and all the founders' shares have been taken up, upon 43,900 of which £9 per share has been called, and the remainder were issued as fully paid. The calls paid amount to £392,500 9s., considered as paid to £21,320, and unpaid to £2,599 11s. Office, Winchester House, Old Broad Street, E.C.

CITY NOTES.

The Electric and General Investment Company, Limited.

The directors have submitted a statement of the accounts for the period ended the 31st May, 1891, showing a net profit of £2,592 6s. available for distribution, which the directors recommend should be appropriated as follows:—That a dividend of 10 per cent., together with a bonus of 12s. 6d. per cent., be paid on the capital paid-up on the ordinary shares, that £266 10s. 9d. be placed to reserve, that a dividend of £1 5s. be paid on each founders' share, that £59 4s. 6d. additional remuneration be paid to the directors, in accordance with the articles of association, and that £16 10s. 9d be carried forward in equal moieties on account of the ordinary and founders' shares.

A large number of proposals of various kinds have been submitted to the board; all of which have received careful consideration, and such as seemed suitable for this company to take up have been fully investigated, but in view of the great financial depression which has existed for some time past the directors have had to proceed with great caution.

The board have now certain important matters in hand which they have every reason to hope will be successfully dealt with and prove remunerative.

The auditors, Messrs. Rait and Kearton, offer themselves for re-election.

BALANCE-SHEET AT 31ST MAY, 1891.

Dr.		£	s.	d.
To Capital authorised— £200,000 in 39,900 ordinary shares of £5 each, and 100 founders' shares of £5 each.				
,, Capital subscribed— 20,000 ordinary shares. 100 founders' shares.				
,, Capital called up—				
£1 per share on 20,000 ordinary ...	£20,000			
£5 ,, ,, 100 founders' ...	500			
		20,500	0	0
,, Sundry creditors		793	4	8
,, Balance profit and loss account		2,592	6	0
		£23,885	10	8

Cr.	£	s.	d.
By Loans against consols	10,000	0	0
,, Investments at market price	1,500	0	0
,, Preliminary expenses	726	0	1
,, Sundry debtors	596	15	0
,, Cash on deposit at bankers	10,000	0	0
,, Cash on current account at bankers	1,062	15	7
	£23,885	10	8

PROFIT AND LOSS ACCOUNT for the period ended 31st May, 1891.

Dr.				£	s.	d.
To General charges, including rent of offices, directors' fees, general expenses, fees for reports, and legal charges and advertising, &c.				1,069	17	4
,, Proposed appropriation of balance—						
Dividend at the rate of 10 per cent. on the ordinary shares .	£2,000	0	0			
Additional remuneration to directors in accordance with the articles of association ...	59	4	6			
Payment to reserve fund ...	266	10	9			
Dividend of £1 5s. on founders' shares	125	0	0			
Bonus of 12s. 6d. per cent. on paid-up capital	125	0	0			
Balance carried forward on account of ordinary shares...	8	5	5			
Balance carried forward on account of founders' shares...	8	5	4			
				2,592	6	0
				£3,662	3	4

Cr.	£	s	d.
By Interest, commissions, and sundry profits ...	3,662	3	4
	£3,662	3	4

We have examined the above balance sheet and profit and loss account with the books and vouchers, and find the same in accordance therewith.

RAIT AND KEARTON (Auditors), *Chartered Accountants.*

The Anglo-Portuguese Telephone Company, Limited.

THE following report was presented at the adjourned fourth ordinary general meeting of the company, held at the offices of the company, 53, New Broad Street, E.C., yesterday:—

The amount to the credit of profit and loss account, after making all deductions, and including the balance brought from last year, is £6,193 15s. 6d. Out of this an interim dividend of 5 per cent. has since been paid, absorbing £2,500, and of the balance it is now proposed to place £2,500 to reserve, and to carry forward £1,193 15s. 6d. to the current year's accounts.

The expenditure on capital account for the year amounted to £6,589 4s. 9d.

The number of paying subscribers at 31st December last was—

In Lisbon, 1,024, of a gross annual value of	£7,530	
,, Oporto, 983, ,, ,, ,,	5,391	
		£12,921

showing a total increase of subscribers of 152, and in value of £1,033. over the preceding year.

The directors are pleased to announce that the Conde de Gouveia, and Mr. Pinto-Basto have rejoined the Lisbon board, and that Dr. Marcal Pacheco has been re-appointed the company's legal adviser in Portugal.

The adjourned general meeting of this company was held yesterday at the offices of the company.

The minutes having been read,

The CHAIRMAN, in rising to move the adoption of this report, said he did so with very great satisfaction. He stated that there had been a steady increase throughout the year, the amount—after making all deductions—in hand being £6,193 15s. 6d. Of this a dividend of 5 per cent. had since been paid, absorbing £2,500, and of the balance £2,500 will be placed to the reserve fund and £1,193 to the current year's accounts. He would mention that the reserve fund now amounted to the respectable figure of £8,500. The number of paying subscribers up to the 31st December are, in Lisbon, 1,024, of a gross value of £7,530, and in Oporto 983 of a gross value of £5,391, making a total of £12,921; thus showing an increase in subscribers of 152, and in value of £1,033 over the preceding year. The account had been further extended to the 31st May, and there was an increase in income and subscribers. There had been since 31st December up to 31st May 61 new subscribers, 26 in Oporto and 35 in Lisbon. The rate was much higher than last year. Considering the disturbed state of Portugal, he considered the account and the balance sheet showed a satisfactory state of things, the crisis had been safely passed, and shareholders were to be congratulated upon the preservation of their property, at a time when such bad feeling was manifest in Portugal against English enterprise.

Caledonian Telephone Company, Limited.

THE prospectus of this company which has been issued states that the company has been formed for the purpose of acquiring from Mr. A. Erskine Muirhead, Cart Forge, Crossmyloof, and 109, Hope Street, Glasgow, the business carried on by him of supplying telephonic communication among traders generally, and more especially of connecting branch offices and departments with the head offices in connection with collieries, railway companies, ironfounders, mill owners, and all public works, also hotels, clubs, warehouses, and other places where immediate communication between different branches is valuable.

The instruments proposed to be used are the French telephone, as made by the Société General des Téléphones, and which is capable of speaking at a distance of over 500 miles.

The registered capital is £50,000, divided into 50,000 shares of £1 each. The present issue is 10,000 £1 shares.

The China and Japan Telephone Company, Limited.

THE following directors' report for the year ending the 31st December, 1890, was presented at the eighth ordinary general meeting of the company, held at the office of the company, 14, Austin Friars, on Tuesday last.

The revenue account, after charging debenture interest, and £137 17s. 6d. in connection with the removal of the exchange at Shanghai to new premises, shows an amount to credit of £815 16s. 11d., which has been transferred to profit and loss account.

Including the sum of £363 16s. 4d. brought forward from 1889, this account shows an amount of £1,179 13s. 3d. to credit, from which the directors propose to write off the sum of £338 0s. 10d. in reduction of capital expenditure, carrying forward the balance.

The £5,000 of 7 per cent. debentures, which fell due on the 1st January last, and which are held by the Oriental Telephone Company, have been renewed, with that company's consent, for another term of five years.

The directors regret to have to record the death, on the 6th December, after a long illness, of Mr. H. C. Erichsen, the chairman of the company, and representative in London of the Great Northern Telegraph Company.

In moving the adoption of the report and accounts, the CHAIRMAN (Mr. H. Grëwing) stated that the general result, as compared with previous years, was rather better, both the revenue and the profits on sales having increased, but the net result was only slightly more favourable. The removal of the exchange at Shanghai to new premises had entailed considerable outlay. The operations of the company were limited to two cities, which were the only places were it was profitable to introduce the telephone. The balance of net profit had been carried forward. The debentures which fell due on January 1st last, and which was held by the Oriental Telephone Company, had been renewed, with that company's consent, for another five years. Besides that, funds were continually being required for further extensions, and as no working capital was available, they had of necessity to fall back upon the revenue.

The motion was seconded by Mr. T. LLOYD, and carried.

The retiring directors and auditors were re-elected.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the past week amounted to £5,798.

The Great Northern Telegraph Company. Receipts in May, 1891, £26,000; 1st January to 31st May, 1891, £114,000; corresponding months 1890, £105,800; corresponding months 1889, £106,800.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 5th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,546.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (June 4).	Closing Quotation. (June 11.)	Business done during week ending June 11, 1891.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p.c., Deb. Regd. and to Bearer	100	99 —102	99 —102	100	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	46½— 47½	46½— 47½	...	...
2,809,310*l*	Do. do. 6 p.c. Preferred	Stock	84 — 85	84 — 85	85¼	84¾
2,809,310*l*	Do. do. Deferred	Stock	11¼— 11¾	11 — 11½	11½	...
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12¼	11¾— 12¼	12⅛	11⅞
84,500*l*	Do. do. 5 p.c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p.c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
63,416	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2¼— 2½	2⅜— 2⅝	2$\frac{7}{16}$	2⅜
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1⅝— 1⅞	1⅝— 1⅞	1⅝	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	4 — 5	4 — 5	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	106 —108	106 —108	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	½— ⅝	½— ⅝xd	½	...
20,000	Crompton & Co., Ltd, 7 p.c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p.c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	...	...
6,000	Do. do. 10 p.c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10¼— 10½	10⅜— 10⅝	10½	10⅜
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝	14½— 14¾	14⅝	14½
70,000	Do. 6 p.c. Preference	10	15 — 15½	15 — 15½	15⅜	...
200,000*l*	Do. 5 p.c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 — 110	...	...
1,200,000*l*	Do. 4 p.c. Mortgage Debenture Stock	Stock	106 —109	106 —109	107¼	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¼— 15	14¾—15¼	15⅛	14⅞
91,800*l*	Do. 5 p.c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p.c. Debenture Stock	Stock	105 —108	105 —108	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p.c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 —107	104 —107	...	...
201,600*l*	Do. do. 4 p.c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5 — 6	5 — 6	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1¾— 2¼	1¾— 2¼	2¼	2
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2½— 3	3¼— 3¾	3¾	3$\frac{3}{16}$
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1 — 1½	1¼— 1¾	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ..., (£4 10s. only paid)	5	2½— 3½	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 9⅝	9⅜— 9$\frac{7}{16}$	9⅝	9$\frac{7}{16}$
180,042	Do. do. 6 p.c. Preference	10	15 — 15¼	15$\frac{3}{16}$— 15⅜	15$\frac{3}{16}$	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	18¼— 18¾	18½— 19	18⅞	...
230,000*l*	Do. do. 5 p.c. Debs. (issue of 1883) ...	100	105 —108	105 —108	107	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10 — 11	10 — 11	...	...
5,334*l*	Do. 7 p.c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19¼	18$\frac{13}{16}$
200,000*l*	Do. do. 4½ p.c., Deb., 1896	100	102 —104	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p.c. Debentures	100	106 —109	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8¾— 9¼	8¾— 9¼	9⅛	8⅞
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝— 4⅞	4⅝— 4⅞	4$\frac{13}{16}$	4⅝
15,000	Do. 6 p.c. Cum., 1st Preference	10	12½— 12¾	12½— 12¾	...	...
15,000	Do. 6. p.c. Cum. 2nd Preference (£8 only paid)	10	11¾— 12¼	11¾— 12¼	...	...
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —106	104 —106	105⅜	104½
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	... — ...	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	8 — 8½	8 — 8½	8	...
3,381	Submarine Cables Trust	Cert.	114 —118	114 —118	116¾	116¼
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4$\frac{11}{16}$	...
37,350	Telegraph Construction and Maintenance, Limited	12	46 — 48	46 — 48	47	46¼
150,000*l*	Do. do. do. 5 p.c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128*l*	Do. do. 5 p.c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p.c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p.c. Debentures	100	96 — 99	95 — 98	...	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	...	...
150,000*l*	Do. do. do. 8 p.c. Debs., repayable 1902 ...	100	100 — 105	100 — 105	...	...
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½	11$\frac{5}{16}$	11⅛
27,873	Do. do. do. 5 p.c. Cum. Preferred	7½	6½— 7	6½— 7	6⅝	...
27,873	Do. do. do. 5 p.c. Deferred	7½	4½— 5	4½— 5	4⅝	...
200,000*l*	Do. do. do. 6 p.c. Debentures "A," 1910 ...	100	104 —107	104 —107	...	...
250,000*l*	Do. 6 p.c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	105¼	104⅛
88,321	West India and Panama Telegraph, Limited	10	3 — 3¼ xd	3 — 3¼	3$\frac{3}{16}$	3⅛
34,563	Do. do. do. 6 p.c. 1st Preference ...	10	11½— 12 xd	11½— 12	11¾	11⅝
4,669	Do. do. do. 6 p.c. 2nd Preference ...	10	9½— 10½	9½— 10½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p.c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
175,100*l*	Do. do. 6 p.c. Sterling Bonds	100	100 —104	100 —104	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	5	4½— 5	4¾—5¼	5	4$\frac{15}{16}$

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* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅝.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 30—34.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid) 4¾—5¼.—Liverpool Electric Supply, £3 paid, 2⅝—2⅞.—London Electric Supply Corporation, Ordinary (£5 paid), 2—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid) 2s. 6d.—5s.—National Telephone Debentures, 2½—3 prem.—St. James's and Pall Mall Electric Light £5, 5⅞—6⅛.—St. James's and Pall Mall, 7 per cent. pref., ⅝ to ⅞ prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅞.—Preference, fully paid 3⅞—4⅜.—Debentures 90—95.—Woods Electric Car, £10 paid, ¾—1.

BANK RATE OF DISCOUNT.—4 per cent. (4th June, 1891).

SOME POSSIBLE MODIFICATIONS IN THE METHODS OF PROTECTING BUILDINGS FROM LIGHTNING.*

DISCUSSION.

Mr. **EDWARD P. THOMPSON**: As I understand the speaker, he proposes to provide a system whereby the electrical energy is not conducted away, but converted into heat. In view of the conduction principle having so often proved a failure, and the conversion principle having succeeded every time, according to the researches of the speaker, and since his theory agrees with well-known electrical principles, I think Mr. Hodges has presented matter well worthy of the consideration of the institute, and I for one, can find no objection to his system as to correctness of principle. As to practical equipment, some incombustible non-conductor, such as asbestos, should be placed between the thin metallic strip and the structure to be protected, or else the melted metal may set fire to the building.

Dr. **WILLIAM E. GEYER**: It seems to me that the occurrence quoted from Franklin tends to show that the ordinary theory of the lightning-rod is essentially true. The bell-wire, so far as it went in the occurrence described, was a lightning-rod, and protected the building so far as that lightning-rod went. It was not heavy enough to carry the current, and it was for that reason dissipated, so that the dissipation was simply an accident. The mere dissipation, however, did not save that part of the building where the wire stopped and there was was no good conductor; the building was without any lightning-rod, and was more damaged than where it had even a small rod.

Mr. **TOWNSEND WOLCOTT**: Mr. Hodges's theory would seem to agree with Professor Lodge's, that if you can use up the energy of the electricity in destroying the conductor you will get rid of it more quickly than you would in any other way, and the lightning will have less effect outside of that. As to the point which Dr. Geyer just mentioned, that Mr. Hodges's experiments support the ordinary theory of the lightning rod, I think his reasoning does, to some extent, too, in regard to getting rid of the energy on the central core. Take the ordinary lightning rod. The way it is intended to work is rather to prevent a disruptive discharge than it is to take care of one that has already occurred. We desire to equalise the difference of potential by drawing off the charge from the cloud before it gets to a dangerous limit. If we can do that, we do not have any disruptive discharge at all. It is just like a brush discharge, such as you get from a conductor with points on an electric machine. I think the fact is not questioned that lightning sometimes is discharged in that way, but not always. There is the trouble. I do not think that any one system of lightning rods has proved successful. Sometimes a lightning rod will take care of several discharges in a single storm, and that seems to be something which Mr. Hodges's lightning rod would not do; because, after it had been dissipated by one discharge, I do not think, even if it could be put up in a few moments, that anybody would care to be monkeying around a conductor when there was lightning. Mr. Hodges, having asked us to clear our minds of the idea of conducting electricity, seems to go further than most of the modern theorists on electricity. I think Mr. Hodges, even if he does not use the idea of electricity, will admit that we want to make a metallic way entirely down to the earth. The case is somewhat analogous to the Leyden jar; that is, two conductors separated by a dielectric. Now, we want to bridge over the whole space of the dielectric, whether you use the idea of conductivity or not. So I don't think it makes much difference whether you use his dissipatable lightning rod or a stout one.

Mr. **HODGES**: I would like to bring the discussion back once more. In order to make the paper of some length, I gave some theory; but the fact as I have found it is this: I know how the books state that the ship *Jupiter* was saved from destruction in spite of her lightning rod going to pieces. But take the fact without going to the books at all. What do the records show? I want to get a case where the conductor has gone to pieces, and where the ship has not been saved. I have not found such a case. Suppose the conductor is dissipated between two points. I found this to be true in every single case of a church tower being struck where the wire runs from the bells to the clock. The wire goes, and the church tower is saved between those two planes. Now, that is a matter of record. The ship *Jupiter* had a chain conductor, and it was dissipated; and the books say that the ship was saved in spite of the conductor being dissipated. But that is a man's opinion. What I want to urge on the Institute is simply this: that in every single case when a conductor goes to pieces everything else is saved. Why and wherefore, I do not care. I gave some theoretical reasoning which seems to me more or less correct, but it is unimportant. I want to bring the discussion back to simply this matter of fact: Can you cite a case where the conductor has gone to pieces, and there has been any destruction to the building between practically two horizontal planes passing through the upper and lower ends of that dissipated conductor? You will find that there is damage above and damage below, very likely. But as I went on through the "Philosophical Transactions," I found one case there of a thunderstorm passing over a village (it was a century ago, or more), and the people were dependent on the church clock for the time. In the morning they did not hear the clock strike. They went up in the church tower to see what the matter was, and found the windows smashed just above the bell; found the wires running from the bell to the clock were gone, and that was all the damage done. To show how small a conductor, when dissipated, will save a house, I will cite the case of a palace in France in the early part of the century. The interior was heavily gilded. The people were sitting around on gilded sofas resting against the walls, resting against thin gilded strips. A fellow of the Royal Society visited the palace the day after it was struck by lightning, and looked over the ground. No one was killed. No damage was done to that palace as far as the gilding extended; that is, in the gilded rooms no damage was done except that the gilding disappeared: it was dissipated. When they got to the lower portions of the palace, where there was no gilding, things were smashed. But, as I say, I started out in this thing with an hypothesis which was to a certain extent wrong. I looked into the records to see what was recorded, not as a matter of opinion, but to find out what actually happened. And what actually happened was, so far as I was able to judge, that there was no case where a dissipated conductor failed to protect a building under these limitations which I state. Of course, above or below, damage did occur.

A **MEMBER**: From a practical standpoint, would you kindly tell us where you put that conductor on a house, and would you put more than one strip on a building?

Mr. **HODGES**: Along the ridge pole, down the eaves, down to the ground. I should avoid, at the lower end, making connection with large masses of metal. The number of strips placed on a building would depend on the size. I got a patent on this thing last year. I told a friend of mine that I was interested in the protection of buildings from lightning, and, a patent not being issued, I could not tell him much about it. The next day he met me and said, "Did you read in the *Post* the account of the lightning storm in Jersey yesterday?" I said, "No." He said, "There was one case where a house was struck by lightning in Jersey and the rod was smashed, but the house was uninjured." I noted it down as another case. A man who was in my employ some years ago came to my office. I described this thing to him, and he said, "I have been there." He said when he was a boy he had a telegraph line running from his house to a neighbour's house. It was made of piano wire, and the lightning struck the roof [illustrating], then followed along the metallic gutter to a point here. This piano wire ran down to the ground, and ran over here to the neighbour's house. At this point a little damage was done to it. The discharge followed along the conductor without doing any material damage, and there was no other damage to the house except that the wire was gone.

Mr. **WOLCOTT**: Although I do not question that conductors work that way, we also find that they work the other way, according to the old theory, in very many instances. It certainly is a matter of record that conductors have sometimes carried off several discharges in the same thunderstorm, which a dissipatable conductor could not do unless you were able to put up a second one in the place immediately after the dissipation of the first.

A **MEMBER**: The Washington Monument is a pretty good lightning arrester. I was shown, a few weeks ago, by Professor Owens, where lightning had struck and knocked out big chunks of stone from the monument. He seemed to think that lightning followed the path of least electrical resistance, so he put up an additional wire and connected that with the new ironwork of the monument, and he says he has not had any trouble since then with stones being knocked out.

Mr. **CHARLES STEINMETZ**: To one point more I wish to draw attention. By using such an interrupted conductor of small cross-section, that is of comparatively high resistance, you are liable to change the whole nature of the lightning discharge. You change it from an oscillating discharge to a steady and continuous rush of current, from which you must expect quite different effects. When, for instance, you discharge a condenser by a conductor of very low resistance, you get an oscillating discharge of an extraordinary high frequency. If you increase the resistance of the conductor, the number of oscillations of the discharge decreases, it runs down quicker, until at last you reach a value of resistance where only one wave of discharge current appears, that is, the discharge of the condenser becomes steady. Now, if we can make a lightning discharge steady, instead of oscillating, then we have first to expect that the electricity traverses the lightning-rod only once, slowly increasing in current strength and then decreasing again by going down to the ground; while in an oscillating discharge the current will rush to and fro through the conductor until its energy is consumed by the resistance of the lightning-rod, or by electro-magnetic radiation and re-radiation from the induced currents produced by the oscillating discharge in neighbouring conductors. This, perhaps, may account for some of those phenomena mentioned to-night; that when the lightning rod is dissipated, that is, when its resistance was very high in comparison with the quantity of electricity rushing through, there was a steady discharge and no harm was done; while, when it is an oscillating discharge, the slightest irregularity will cause the discharge to "jump the track," that is, to leave the lightning rod, which is obstructed by the counter electromotive force of self-induction, and to spark over to metal masses of larger condenser capacity: for what I consider as the most dangerous part of lightning discharges is not the enormous voltage of the discharge, nor the strong current rushing through the lightning rod, but the electro-magnetic field of force, which alternates with enormous frequency and reaches far out into space from the real path or centre of disruptive discharge, and thereby must cause inductive effects everywhere, which, as before said, cause not only the main discharge to spark over, but produce true secondary or induced lightning discharges. Hence I must be very much in favour of every arrangement which is able to change the oscillating discharge into a steady rush of current. The resistance of the lightning rod I consider as of subordinate importance only, except so far as carrying capacity is concerned; for of what use is a resistance as low as a few ohms, when the self-induction of the lightning rod causes a spurious resistance of perhaps hundreds of thousands of ohms?

Dr. **GEYER**: In a disruptive discharge, the length of the lightning rod, it seems to me, is a very small part of the total path. I should imagine that any resistance the conductor would have would be such a small part of the total that it would not have much effect on the character of the discharge.

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* A paper, by N. D. C. Hodges, read at the fifty-sixth meeting of the American Institute of Electrical Engineers, New York, April 21st. See REVIEW for May 15th, page 609.

Mr. Steinmetz: I believe I have been misunderstood in what I meant by the influence of the resistance upon the nature of the discharge. Indeed, the whole resistance of the lightning circuit is so large that under any circumstances the resistance of the lightning rod is imperceptibly small. But, as explained in my former remark, it is not the resistance proper, but the consumption of energy by the resistance, which causes the amplitude of the oscillating discharge to decrease slower or quicker until, for a very rapid consumption of energy by resistance, only one wave appears that is a steady or continuous current. This phenomenon is similar to a pendulum oscillating in a liquid; the greater the frictional resistance of the liquid, the quicker the amplitude of the pendulum motion decreases, until, at last, in a very tough liquid, the pendulum comes to rest without any oscillation at all—periodically. In such a way the resistance of the conductor, by consuming the energy of the electric discharge, could change the discharge from an oscillating to a continuous one, although the whole "resistance" has still about the same value, "infinite," if we were allowed to speak with the usual meaning of "resistance" of disruptive discharges, which we are not.

ANNUAL CONFERENCE OF POSTAL TELEGRAPH CLERKS.

The Postal Telegraph Clerks' Association held their annual meetings in Edinburgh on Friday and Saturday last. On Friday evening the delegates dined together in the Royal Hotel.

The chair was occupied by an Edinburgh Representative, who read telegrams from Glasgow, York, Liverpool, Sheffield, Dublin, Nottingham and elsewhere, wishing success to the meetings.

In proposing the toast of the Postmaster-General,

A Delegate from Manchester said they were all grateful for what he had done for them in his last scheme, but they would have been more grateful had he given more spontaneously and simultaneously all over the country. After referring to the manner in which their position had been improved by this scheme, the delegate went on to mention the things which he hoped the Postmaster-General would do for them before he resigned office. One was that he would restore the Cardiff men to their work, seeing that he had exiled them without cause. He hoped also the Postmaster-General would improve the position of the second class operators, and so prevent them from going into foreign service. Again they wanted, and claimed as their right, freedom of speech, and hoped Mr. Raikes would rescind the order which forced on their meetings the presence of an official reporter.

A Delegate from Swansea, in replying, said it would be rank folly and ingratitude for them to deny the benefits they had received from the present Postmaster-General.

In proposing the "Postal Telegraph Clerks' Association," the Chairman sketched the history of the Union, and described the troubles which had beset its formation. Now, he said, their grievances were reduced almost to a minimum, but what they would still like to have was the abolition of classification and the increase of their maximum. He would also like the question of separation to be gone more in for, because as long as they were under the Post Office they could never be what they ought to be.

In replying, a Liverpool Representative said that out of a total of 6,000 telegraph clerks in the Government service, 4,680 were members of the Union. By a little effort, he thought they should raise that number to 5,500.

The tenth annual Conference of the Association was held on Saturday in the Royal Hotel.

Mr. Thomas Warden, Edinburgh, who presided, welcomed the delegates, remarking that their numbers, and the distances from which they had come, testified to the vitality and progress of their movement. Since the last Conference at Leicester, the Postmaster-General had made several very important concessions. They were specially grateful for the payment for Sunday duty, but he was sorry to say the Department had minimised their concession to a certain extent, in as far as what was reckoned Sunday duty prior to the issue of Mr. Raikes's scheme, was now treated in a different manner.

Mr. Thomas D. Venables, general secretary, Liverpool, submitted the statement of accounts for the year ending February 28th, 1891. The report, he said, was in every respect, satisfactory. The year was begun with an insurance balance in hand of £1,521 13s. 9d., and ended with a balance of £1,605 10s. 4d., being a gain of about £84. The general account balance at February last was £207 3s. 8d., as compared with £127 3s. the previous year, and that after a year of exceptional activity. The membership had increased from 4,578 to 4,648. The insurance branch had also been very successful, and they should press upon their younger members the advantage of a cheap insurance suitable to their scanty earnings. The working expenses were only 7s. 4d. more than last year, notwithstanding the great expense they had been put to in paying a qualified reporter to act as a check on the official note-taker. By the full reports so obtained, however, their members were no doubt able to take a deeper interest in matters affecting them. The official reporter had not yet been cashiered, but his visits were more and more rare. Let them strive to hasten the time when he should be a dim memory and nothing more. The report was adopted.

A London Delegate moved a resolution that "This Conference is of opinion that considerable dissatisfaction still prevails in the service, and that Mr. Raikes's revision has not redressed all the grievances under which we suffer; and that, moreover, the late scheme presents several anomalies and inequalities." Since the staff had been largely increased in London, he said, they had not had a single superior appointment, and therefore this increase did them no good.

A Belfast Delegate moved, as an appendix to this resolution: "That the number and value of superior appointments in the telegraph branch should be in proportion to the number of clerks employed, and that the proportion should be equal to that enjoyed by the postal branch." The resolution and appendix were unanimously agreed to.

An Edinburgh Delegate moved: "That what is known as the Dublin resolution (which claimed a maximum salary of £156 per annum) be rescinded, and a claim for a maximum salary of £200 per annum, as arranged at the Belfast Conference, be reverted to." He pointed out that the Department were getting more and much better work from its servants than formerly, and that the operators' salaries did not increase in the same proportion as those of the superior officers.

A Manchester Delegate seconded.

A Newcastle Delegate moved as an amendment to this motion: "That the Dublin resolution shall be rescinded, and that the commencing salary of the general body of provincial telegraphists shall be as at present fixed, but that the classification of these officers into three classes be abolished, the entire body to consist of one class, and that the annual increment be 2s. per week up to 22s., and at the end of five years' service the salary to increase to 28s. per week, rising by 2s. 6d. per week, until the maximum salary be reached, which should be fixed at £200 per annum." After some discussion, the Edinburgh delegate withdrew his motion in favour of the amendment, which became the finding of the meeting.

A Belfast Delegate moved that promotion to all appointments in the telegraph service above the rank of a probationer, be by efficiency, conduct and seniority, and not by selection and seniority alone, the appointments to be made on passing a qualifying examination. On a division only two supported the resolution, which was not adopted.

On the motion of an Edinburgh Delegate, seconded by a representative from Swansea, a resolution was adopted pledging the meeting to take action for the abolition of the system of classification.

A Bristol Delegate called attention to the Pension Act, and moved that the Central Committee of the Association be requested to take steps to obtain compensation to the relatives of members of the Postal Telegraph Service who die whilst in actual work, and that all service performed as overtime should be added to actual service when pensions are being computed.

The resolution was adopted.

A Representative from Newport-on-Usk moved a resolution pointing out that all other channels of communication having been denied them, they now appealed to the Postmaster-General through the channel of the official reporter (if one were present), in the hope that he might withdraw any stigma of suspicion from the "Cardiff exiles." In deference, however, to the wish of the meeting, the speaker withdrew his motion.

A Dublin Representative held it was quite undignified to recognise the official note-taker at all.

The feeling of the meeting seemed to be against discussing the Cardiff case at this time of day.

The same Representative from Newport-on-Usk (setting forth that the presence of an official note-taker contravened the elementary rights of British subjects, and instructing the Central Committee to approach the Postmaster-General by a second united petition for the abrogation of the circular authorising the employment of the note-taker), in moving the resolution, commented on the fact that no official note-taker was present.

A Cardiff Member said that, at a meeting they held there, the Government not only sent an official reporter but the assistant-superintendent was present to take the names of all the speakers.

A Representative from Swansea told how, in order to keep out an objectionable individual there, they turned their meeting into a smoking concert. (Laughter.) But the official reporter would not go away. He said he had never met such a jolly set of fellows. (Laughter.)

A Dublin Delegate did not see why they should be afraid of the official note-taker, and he moved as an amendment the deletion from the motion of any reference to the personal risk attendant upon those carrying on the present campaign. He further proposed that each office, and not the Central Committee, forward petitions.

A Glasgow Member spoke of the courtesies extended to the staff by his Postmaster. He always put a meeting place in the office at their disposal free of charge.

The amendment was carried by a very large majority.

After some discussion it was agreed that at the coming Parliamentary elections, all candidates be approached on the question of the rights of free speech, and be got, if possible, to promise enquiry into the whole question of the administration of the telegraphs.

A resolution providing for a return under the heading of Vital Statistics, showing the average age at death amongst telegraph clerks, and the cause of death, as far as can be ascertained, was submitted and agreed to, with an addition for a return of those suffering from telegraph cramp.

A Liverpool Delegate moved that the conference, while warmly acknowledging the sympathy and assistance given to members on several occasions, did not consider it advisable nor practicable to affiliate the branches of the association with the trades councils of the United Kingdom.

A Manchester Delegate having seconded, the resolution was adopted.

The meeting then discussed certain alterations in the rules of the association, and thereafter sat in private.

PROCEEDINGS OF SOCIETIES.

Royal Society, June 4th.

"QUADRANT ELECTROMETERS." By W. E. AYRTON, F.R.S., J. PERRY, F.R.S., and W. E. SUMPNER, D.Sc. Received May 19th, 1891.

(*Abstract.*)

IN 1886 it was noticed, on continuously charging up the needle of Sir William Thomson's bifilar suspension quadrant electrometer, No. 5, made by Messrs. White, of Glasgow, and in use at the laboratories at the Central Institution, that the deflection of the needle, when the same P.D. (potential difference) was maintained between the quadrants instead of steadily increasing, first increased and then diminished; so that, both for a large charge on the needle as well as for a small, the sensibility of the instrument was small. A similar effect had been described by Dr. J. Hopkinson, in the "Proceedings of the Physical Society," vol. 7, Part 1, for the previous year, and the explanation he gives of this curious result is, that if the aluminium needle be below the centre of the quadrants, the downward attraction of the needle, which varies with the square of the needle's charge, increases the pull on the bifilar suspension, and so for high charges more than compensates for the increased deflecting couple due to electrical action. On raising, however, the needle of our electrometer much above the centre of the quadrants, the anomalous variation of sensibility of the instrument with increase of charge in the needle did not disappear, and even when the needle was raised so that it was very close to the top of the quadrants, and when, if Dr. Hopkinson's explanation were correct, the sensibility (or deflection corresponding with a given P.D. between the quadrants) ought to have been very great for a large charge on the needle, it was, on the contrary, found to be small.

The needle was carefully weighed, with the platinum wire attached and the weight dipping into the acid, and a calculation was made as to the magnitude of the effect that should arise from the change of the pull of the fibres due to any upward or downward attraction of the needle by the quadrants. This calculation showed that for a P.D. of 3,000 volts between the needle and the quadrants, the amount of such attraction was quite unable to account for the observed diminution of sensibility with large charges in the needle. Dr. Hopkinson says in his paper, "Increased tension of the fibres from electrical attraction does not therefore account for the whole of the facts, although it does play the principal part." The experiments that we made at the end of 1886 and beginning of 1887, confirmed by the calculation above referred to, proved that, at any rate in our specimen of the quadrant electrometer, the principal part of the anomalous action was not caused by an increased tension of the fibres, and that therefore some other cause must be looked for to explain the observed results.

An investigation, which turned out to be both lengthy and very laborious, was therefore undertaken to ascertain the cause of this curious behaviour of our White electrometer. At first we thought that it might be due to some capillary action between the platinum weight and the sulphuric acid, which varied with the potential of the acid, but, experiment having shown that this was not the explanation, we decided to make an exhaustive series of experiments for determining the laws connecting the variation of sensibility of the White quadrant electrometer with the potential of the needle, the distance between the silk fibres, and the distance between the quadrants. The investigation has occupied us on and off for some years, and in carrying it out the quadrant electrometer has had to be taken to pieces many times.

To facilitate the frequent removal of the interior of the Leyden jar, rendered necessary for carrying out the various experiments, an improvement was introduced into the method of clamping the needle, and to diminish leakage, an improvement was introduced into the replenisher, both of which are described in detail in the paper.

The P.D. between the needle and the outside case of the electrometer was measured by means of one of Sir William Thomson's absolute electrometers, made especially sensitive by thinning the coach springs supporting the attracted aluminium disc.

In July, 1888, several large P.Ds. were measured by means of this absolute electrometer (using the constants that we had determined for this instrument), and by means of one of Sir William Thomson's commercial "electrostatic voltmeters," reading to 20,000 volts, kindly lent us by Messrs. Elliott Brothers. The result of these comparisons led first to a correction in the constants that had been previously sent out with the electrostatic voltmeters from Glasgow, and secondly, to a new determination of the value of "*v*." For Sir William Thomson had calibrated these voltmeters electro-magnetically on the basis of the value of the electro-chemical equivalent of silver, as determined by Lord Rayleigh and Mrs. Sidgwick, while we had checked the calibration of the electrostatic voltmeter by comparing this instrument with the absolute electrometer. The value of "*v*" thus obtained was 298 million metres per second.

From the experiments made on varying the distance between the fibres supporting the needle of the quadrant electrometer, it was found that, when the control due to the fibres was large, the sensibility of the quadrant electrometer increased more rapidly than the potential of the needle, whereas, when the control due to the fibres was small, the sensibility increased with the potential of the needle up to a certain point, ond then diminished again as the potential of the needle was still further increased.

From experiments made by varying the distance between the quadrants, we found that when the distance between the quadrants was small, the sensibility first increased as the potential of the needle was raised, then it diminished, and finally it increased again for a still further increase of the potential of the needle. The curve, therefore, connecting sensibility with potential of the needle was invariably of an ∿ shape for a small distance between the quadrants.

As the distance between the quadrants was increased, the sensibility curve flattened, becoming practically straight when the distance separating the quadrants was 3·9 mm. For a greater distance than this between the quadrants, the sensibility increased more rapidly than the potential of the needle.

The various curves accompanying the paper show that this quadrant electrometer may be adjusted so that the variation of sensibility with the potential of the needle may be made to follow one or other of *three distinct laws.* If the quadrants be near together, there are certain limits between which the potential of the needle may vary without producing more than a small change in the deflection corresponding with a fixed P.D. between the quadrants; for example, when the quadrants were about 2½ mm. apart, and the fibres near together at the top, the deflection produced by a P.D. of 1·45 volts between the quadrants only varied about 11 per cent. when the potential of the needle varied from 896 to 3,586 volts. When the fibres were far apart at the top, it was when the quadrants were about 1 mm. apart, as seen in Sheet III, that a similar flatness was obtained in the curve connecting deflection with potential of the needle. In this case the deflection of the needle was practically quite constant when its potential varied between 2,152 and 3,227 volts, and even when the potential of the needle was increased from 1,434 to 3,407 volts, that is, by nearly 2,000 volts, the deflection did not increase by as much as 9 per cent. This arrangement of the quadrants gives but a comparatively small sensibility, but, where great sensibility is not required, it would be a convenient one to employ, as leakage of the Leyden jar, or loss of potential of the needle due to the rapid absorption that occurs when the jar is first charged, would only slightly affect the deflection for a fixed P.D. between the quadrants.

When the quadrants were at about 3·9 mm. apart, the deflection for a given P.D between the quadrants was almost directly proportional to the potential of the needle. This, then, would be the arrangement to employ when the electrometer is used with alternating P.Ds. And lastly, when the quadrants were 4 mm. or more apart, the deflection increased much more rapidly than the potential of the needle, so that maximum sensibility, bordering on instability, is obtained with this arrangement of the quadrants.

After carrying out a large number of experiments, the cause of the irregularity in the action of the Thomson quadrant electrometer, as made by Messrs. White, began to dawn on us. The wire supporting the aluminium needle, as well as the wire which connects the needle with the sulphuric acid in the Leyden jar, is enclosed in a metallic guard tube to screen the wire from external action. But, in order that the needle may project outside the guard tube, openings are made in its two sides. Hence the moment the needle is deflected from its zero position, each half of the needle becomes unsymmetrically placed relatively to the two metallic pieces which join the upper and lower half of the guard tube. Therefore, in spite of the needle and the guard tube being always maintained at the same potential, there is a repulsion between the charges on the two connecting pieces of the guard tube and the charges on the two halves of the needle. And this repulsion has not only the defect of seriously diminishing the sensibility of the quadrant electrometer as made by Messrs. White, but causes the variation of sensibility of the electrometer with variation of the P.D. between the needle and the outer coating of the Leyden jar to follow a far more complicated law than that expressed by the conventional formula just given.

To test this theory, that the peculiarities in the law of the quadrant electrometer are due to the electric action of the guard tube on the needle in consequence of the special shape of the former, we intensified and varied the want of symmetry of the guard tube by attaching a piece of thin aluminium foil to it above and below the needle, and experiments made on the law connecting the sensibility of the electrometer with the potential of the needle showed that the law could be much altered in character by a slight shift in the position of the piece of aluminium foil.

The paper then goes on to describe experiments connecting the motion of the electrical zero with the potential of the needle, and with the position of the adjustable quadrant.

Guided by the results of a long course of experiments on the White electrometer, we were led, with the assistance of Mr. Mather, to construct an improved unifilar quadrant electro-meter which is fully described and illustrated in the paper. This improved electrometer differs in numerous particulars from that made by Messrs. White. The bifilar suspension is abandoned for reasons given in the paper, and a new form of adjustable magnetic control employed. All the working parts are supported from the base, so that on removing the glass shade, which serves as the Leyden jar, all the parts can be got at and adjusted *in position*; all the insulated stems are made of glass, and are under cover, protected from dust and damp; the needle, quadrants, and guard tube are so shaped that, in whatever symmetrical position the quadrants be placed, the deflection produced by a given P.D. between the quadrants is directly proportional to the potential of the needle, and further, this improved electrometer is at least ten times as sensitive as our specimen of the White pattern when the instruments are adjusted to be in equally trustworthy condition as regards definiteness of the zero and of the deflected position of the spot of light.

Next follows an account of some experiments made by us on a White electrometer, the needle of which Mr. Boys had suspended with a single quartz fibre. Although this instrument was in excellent condition as regards definiteness, &c., the raising of the potential of the needle to only 400 volts was sufficient to show that the sensibility was not proportional to the needle's potential.

Lastly, for the purpose of obtaining conclusive evidence as to whether our idea was correct about the connecting pieces of the guard tube in the White electrometer, causing the sensibility of this instrument to be in many cases actually less when the needle had a high potential than when it had a low, we had constructed a little collar with two legs. This collar could be clamped to the upper portion of the guard tube of the improved electrometer with the legs projecting down into the quadrants on each side of the needle, and experiments showed that when this collar was attached to the guard tube the improved electrometer, although not a bifilar instrument, became as bad as the White pattern. For while before the attachment of this collar the sensibility increased proportionately to the potential of the needle, after the collar was attached the sensibility first increased and then diminished again as the potential of the needle increased, and with the same adjustment of the quadrants, controlling magnets, &c., and with the needle charged to a potential of 1,300 volts, the mere attachment of this little collar reduced the sensibility to one quarter.

The paper concludes with a sketch of the mathematical investigation that we carried out, and it is explained that by taking into account the electrical action of the connecting pieces of the guard tube of the White electrometer, the diminution in this action as the quadrants are pulled out, the alteration produced by the tilting of the needle at high potentials on the magnitude of this electrical action as well as on the rate of variation, per radian deflection of the needle, of the coefficient of induction between the insulated pair of quadrants and the needle, an expression was obtained for the deflection of the needle in terms of its potential and the P.D. between the quadrants. And this expression, although containing only three constants, fitted with considerable accuracy all the curves given in the several sheets accompanying the paper.

The results of the investigation, briefly summed up, are as follows:—

1. The quadrant electrometer as made by Messrs. White, although it may be carefully adjusted for symmetry, does not usually even approximately obey the recognised law for a quadrant electrometer when the potential of the needle is altered.

2. The peculiarities in the behaviour of the White electrometer are due mainly to the electrical action between the guard tube and the needle, and to the slight tilting of the needle that occurs at high potentials.

3. By special adjustments of the quadrants of the White electrometer the sensibility can be made to be either nearly independent of the potential of the needle, or to be directly proportional to the potential, or to increase more rapidly than the potential of the needle.

4. By altering the construction of the instrument as described, the conventional law for the quadrant electrometer is obtained without any special adjustment of the quadrants beyond that for symmetry, and the instrument is rendered many times as sensitive as the specimen we possess of the White pattern.

NEW PATENTS—1891.

8,499. "Improvements in apparatus for controlling electric currents." R. E. B. Crompton. Dated May 19th.

8,575. "Improved methods of and apparatus for generating and utililising electric energy for lighting purposes." N. Tesla. Dated May 19th. (*Complete.*)

8,579. "An improvement relating to electrical belts, chiefly designed for medical purposes." C. B. Harness. Dated May 19th.

8,609. "Improved pipes or leads for electric conductors." T. Smith. Dated May 20th.

8,722. "An improved form of carrier for shades and globes for gas and electric light." J. G. S. Cunnington. Dated May 22nd.

8,735. "Improvements in electrical storage batteries or accumulators." E. W. Berdoe and G. M. Shum. Dated May 22nd.

8,742. "Improvements in electrical organs or similar instruments." R. Hope-Jones. Dated May 22nd.

8,806. "Improvements in dynamo-electric and electro-dynamic machines." A. I. Gravier. Dated May 23rd.

8,808. "Improvements in and relating to electrical batteries." W. J. Green. Dated May 23rd.

8,811. "Improvements in and relating to electric meters." G. Mengarini. Dated May 23rd.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1890.

1,031. "Electric compass and course recorder." J. von Peichl. Dated January 21st. 8d. The electric compass which may or may not have a visible card, and is subject to the usual correctors, is gimballed within a casing or frame movable round a vertical axis, and carries a contact arm which normally lies between without touching two conductors leading from a battery or other source of electricity to a clockwork gearing which is started in either direction according as the compass arm touches the one conductor or the other, and stopped when it touches neither. This gearing is conveniently mounted in the lower part of the binnacle, and driven by a weight or spring. It is so arranged that whenever, owing to a turning movement of the vessel, the compass arm makes contact with one of the conductors, the gearing causes the compass frame to turn in the direction opposite to that in which the vessel is turning, the compass arm thus remaining in contact with the conductor. When the compass frame has so far turned that the contact of the arm with the conductor ceases, the arm then freely playing between the two conductors, the circuit being then opened, the movement of the frame is stopped. Thus the compass frame is always brought to a position corresponding with the direction of the compass needle, and it may serve to indicate the course by a suitable cord or disc or index attached to it, in which case the compass itself need not have a card. 4 claims.

2,659. "Improvements in electric arc lamps for use in search light projectors and other purposes." The Honourable C. A. Parsons Dated February 19th. 8d.

3,028. "Improvements in dynamo-electric and electro-dynamic machines." A. C. Reignier. Dated February 25th. 8d. The armature axis is fixed, the drum being made to revolve upon it, and upon the axis is fixed a magnetic core; the coiling of the armature consists of groups of laminæ, which are successively of insulating material, of iron, of copper, of iron, of insulating material, of iron, of copper, of iron, of insulating material, and so on. The copper laminæ are extended, and serve as conductors, which terminate in collecting conductors of iron or steel. Between the groups of the armature are iron wedges, filling the angular gaps produced, and secured by bolts. 4 claims.

3,660. "Improvements in apparatus for connecting and disconnecting electric circuits." S. B. McClellan. Dated March 7th. 6d. The inventor employs a rod mounted in bearings so as to be capable of sliding longitudinally when required. There may be a spring placed on this rod so as to give it a tendency to advance in one direction longitudinally. On this rod he provides screw or other contact pieces which connect or disconnect electric circuits on the movement of the rod in a longitudinal direction. 3 claims.

3,969. "Improvements in switchboards for stations of electrical supply." Siemens Bros. & Co. (Communicated from abroad by A. M. Taylor, of India.) Dated March 13th. 6d. On a board of wood or other insulating material are placed a number of parallel bars each connected at one end to one of the terminals, say the + terminal, of one of the dynamos. Across these parallel bars, but not in contact with them, are placed a number of other parallel bars, each connected at one end to one of the leads, through a switch, and preferably also through a safety fuse and a current indicator. By means of suitable plugs, inserted where the bars cross each other, any one or more of the first-mentioned parallel bars can be connected to one or more of the cross bars, and thus any of the dynamos may be connected to any of the leads switched in. 1 claim.

4,053. "Improvements in safety devices for high-pressure electrical currents and indicating apparatus in connection with same." B. M. Drake and J. M. Gorham. Dated March 15th. 6d. Refers to a modification of the static safety device patented by Philip Cardew, No. 15,484, 1887, and consists substantially of a foil attached to a metal plate at one end, the two being suspended vertically, and the other end of the foil being left free. The combined foil and plate are connected either to earth or the circuit which it is desired to protect, and at a short distance a separate plate is fixed to which the other connection is made. 2 claims.

4,275. "Improvements in electrical switches." J. A. Kingdon. Dated March 19th. 8d. The inventor constructs a double pole switch of a long roller of wood or other insulating material, supported at either end in bearings so as to be capable of rotation. Near the ends of the roller metal arms or springs project which can make contact with springs or other metallic pieces fixed on the base of the switch. A third arm near the centre of the roller, at a distance from the contact arms, is pivoted to a long rod, by means of which the switch is rotated through about a quarter of a turn, so as to put the switch on or off. 5 claims.

4,921. "Improvements in galvanometers." J. Perry. Dated March 29th. 4d. Relates to an improvement on the original Ayrton and Perry solenoid galvanometer, whose dial could only be horizontal, to enable the dial to be vertical or to be in any other direction, so that the instrument may be attached to a wall or a switchboard. The attracting coil's axis being nearly horizontal, the attracted object, whether an iron core or another coil, is slung by fine wires or strips of material, so that it may have a motion like that of the bob of a pendulum, or rather of a battering ram. The inventor prefers to use two wires or strips for each sling, the two making an angle with one another in the form of the letter V; this gives lateral stability. 2 claims.

7,670. "Electric meter." C. D. Abel. (Communicated from abroad by the Société Anonyme Continentale pour la Fabrication des Compteurs à Gaz et autres Appareils of Paris.) Dated May 16th. 11d. The meter is composed of three main parts:—1. A chronometric electro-motor with uniform motion, serving to actuate periodically the mechanism of the meter. 2. A torsional electro-dynamometer watt-meter, the movable bobbin of which is fixed at the end of a spring or torsional thread, the other end of which is connected at the required moment with the electro-motor. 3. A counter or registering mechanism which advances periodically to the extent of the angle through which the end of the spring of the electro-dynamometer has to be turned for bringing the movable bobbin into a condition of equilibrium in a determined position which shall always be the same at every measurement, and which starts from the point corresponding to the same equilibrium when the E.M.F. = 0. This angle measures accurately the E.M.F. of the current in consequence of the proportion existing on the one hand between the electro-dynamic actions and the intensity of the current, and on the other hand between the efforts exercised by the spring and the angles of torsion. 7 claims.

19,155. "Improvments in electrical storage batteries or accumulators." H. H. Lake. (Communicated from abroad by G. E. Hatch, of America.) Dated November 25th. 6d. Consists in using stiff, porous material, honeycombed or provided with holes, pits, grooves or depressions, as separators and supporters of the metal plates, and in applying the active material to the porous plates instead of the lead plates as has heretofore been the practice. 4 claims.

19,406. "Improvements in electric current meters." E. Hartmann and W. Braun. Dated November 28th. 6d. Relates to an improved arrangement whereby the relatively small elongation of a wire or conductor, due to the expansion resulting from the heat generated by the passage of the current to be measured, is converted into a relatively extensive displacement of the hand or pointer indicating the strength of the current. 2 claims.

19,806. "Improvements in circuit controllers or switches for incandescent electric lamps." N. Marshall. Dated December 4th. 6d. Consists in certain novel features, the object being to produce a simpler, cheaper and more effective device of this character than is now in ordinary use. 8 claims.

REVIEWS.

A Treatise upon Wire: its Manufacture and Uses; embracing Comprehensive Descriptions of the Construction and Applications of Wire Ropes. By J. Bucknall Smith. London: Offices of *Engineering*. New York: John Wiley and Sons.

This volume is probably the first of its kind that has appeared. It might be imagined, perhaps, that the subject of wire does not admit of an elaborate treatment, but Mr. Smith's work proves that there has been a large mass of information existing which only required to be brought together. The process of manufacturing wire by drawing appears to be comparatively a modern idea, not dating further back than the 14th century, though shreds of wire are said to have been discovered which date as far back as B.C. 1700. The uses of wire it is perhaps almost needless to say are endless, and these uses are continually being added to. Amongst the most recent and novel applications may be mentioned the use of wire for constructing guns, and for flywheels. Heavy flywheels, driven at high velocities, present dangers of breaking asunder, from the great centrifugal force developed, and to avoid these dangers is important. At the Mannesmann Tube Company's Works, Germany, a flywheel has recently been constructed consisting of a cast iron hub or boss, to which two steel cheeks are fixed, about 20 feet in diameter. The space between the discs is filled with some 70 tons of No. 5 steel wire (about 250 miles) compactly wound. This huge flywheel is driven at a peripheral velocity of 2·8 miles per minute. In Section I., which follows the introductory portion of the work, the different qualities of iron and steel are explained, the wire made from these ranging from a breaking strain of 25 tons per square inch for black or annealed iron, to 170 tons for special qualities of steel. The principle of continuous rolling, *i.e.*, the drawing of small wire from the largest gauge by a series of continuous operations in one machine is of recent date, having been introduced in 1862, but not practically worked apparently till some 10 years or more later. The various machines which have been devised for the purpose are illustrated and described. Referring to galvanising it is stated, what is, we believe, not generally known, that tinning wire does not act as a preservative, inasmuch as the iron is attacked and not the tin, the reason of this is, however, obvious. The manufacture of superior grades of steel rope wire is an important speciality in the trade, and the wear which these ropes undergo when used for haulage purposes is very considerable, and many forms of these ropes have been patented. One of the most successful of the same appears to be that constructed with the "Lang" lay, which consists in having the wires composing the strands and the strands forming the rope, both laid in a right hand direction, so that the component wires follow a dextral spiral axially to the rope. As constructing engineer to the Patent Cable Tramways Corporation and the Steep Grade Tramway Company, Highgate, &c., the author is naturally a strong advocate of this system of haulage, and he states that it is "capable of earning unparalled dividends." Electrical traction he considers as a "fashionable hobby." The chapter on "Electrical Conductors" is comparatively brief, and is confined to matters bearing directly upon a few forms of uninsulated wires and specifications relating thereto. The book is undoubtedly a useful one, being well got together, well printed, and well illustrated.

The Arithmetic of Electrical Measurements with numerous examples fully worked. By W. R. P. Hobbs. Revised edition. London: Thomas Murby, 3, Ludgate Circus Buildings.

The general style of the present edition of this useful little book is the same as that of the original work, but a general revision has been made, and one of the chapters, that relating to electric lighting, has been re-written. The author (who is the headmaster of the Naval Torpedo School, Portsmouth), might, we think, with advantage, extend the scope of the book.

Journal of the Institution of Electrical Engineers. No. 93. London: E. & F. N. Spon, 125, Strand.

The general contents of this number are as follows:—"Notes on the Design of Multipolar Dynamos," by W. B. Esson; "A Few Calculations on Electrical Shocks from Contact with High Pressure Conductors," by Major P. Cardew, R.E. Original communications:—"Earth Currents in India," by E. O. Walker; "On Signalling across Rivers in India with Cardew's Vibrating Sounders," by W. F. Melhuish. Abstracts, &c.

Smith's Tables and Memoranda for Mechanics, Engineers, &c. Selected and arranged by Francis Smith. Fifth edition. Revised and enlarged, with a new section of electrical tables, formulæ, &c. London: Crosby Lockwood & Son, Stationers' Hall Court.

Clearly printed, of a miniature size, and with well selected matter, this book is a most useful one, as, indeed, the demand for a fifth edition has proved. The addition of an electrical section was a necessity of the age, and adds considerably to the value of the work.

Telegraphy. By W. H. Preece, F.R.S., and J. Sivewright M.A., C.M.G. Ninth edition. Revised and enlarged. London: Longmans, Green & Co.

The very complete revision which this well-known standard work has undergone quite justifies the statement made in the preface, that "the present edition may fairly claim to be almost a new book." Mr. Arthur J. Stubbs, one of the technical officers of the Post Office Telegraphs, who, it is stated, has taken general charge of the revision, has done his work with great completeness and care, and the book as it now stands is more useful than ever. Whilst a large amount of new matter and new figures have been added, the pruning knife has been freely applied and obsolete information has been excluded. As regards entirely new matter, we have a chapter on the multiplex system and another on instruments for testing; an appendix of several sections, dealing with such subjects as "Ohm's Law," "Combined Resistances," "Shunts," "The Winding of Electro-Magnets," &c., is a very useful addition. In the chapter on instruments for testing we notice one or two slips, the tangent of 30° (page 345) is stated to be $\frac{\sqrt{3}}{2}$; again, on page 356 we are told that in using the Wheatstone bridge the battery key should first be depressed, and then the galvanometer key "as otherwise the self-induction of the *galvanometer coils* acts on the needle." As a manual of modern telegraphy the book now leaves little to be desired.

CORRESPONDENCE.

The Elmore Copper Companies.

In reference to Mr. Watt's letter in your issue of last week which may be considered, by those not knowing the facts, to reflect upon Mr. Elmore, I beg to say in regard to Mr. Justice Kay's judgment Mr. Watt has evidently forgotten to state that on January 13th, 1888, shortly after the date of the decision referred to, a copper tube was manufactured by the Elmore process with a tensile strength of 41 tons to the inch which was tested by Prof. Unwin, a copy of whose certificate I enclose herewith. The circumstances referred to by Justice Kay were all most minutely investigated by the highest experts, and even by Dr. John Hopkinson who was engaged against the Elmores at the trial and their reports in reference to this very circumstance appeared in the prospectus when the original Elmore company was formed.

An Elmore Shareholder.

[This is the letter which was missing and to which we referred at the end of our correspondence for May 8th.—EDS. ELEC. REV.]

Electrostatic Inductive Capacity.

With regard to the correspondence contained in your columns of May 1st, relating to the electrostatic capacity of single and return systems of telephone circuits, the following may be of use.

It is well known that the retardation due to electrostatic capacity on a telephone circuit is not increased by using a return wire in place of a single wire; such being, I believe, generally accounted for in a rather vague manner by saying that although the resistance is doubled, the "effective" capacity is halved. Now it stands to reason that the absolute capacity of such a system is increased by using a return wire. I therefore venture to submit the following explanation as to why the retardation due to electrostatic capacity is not increased in the latter case.

The retardation due to static capacity is proportional to the time taken to completely charge and discharge the line. I will first take the case of charging, as the time taken to charge is not identical with the time taken to discharge. In a single wire system, as shown in fig. 1, the charge on the line is represented by the area *a x b*, the slope, *a b*, representing the fall of potential along the line, and the amount of charge at any point on the line by the length of the perpendicular to *x b*, from that point intercepted by *a b*. Now, the charging resistance (r) of the line if the charge were uniformly distributed along the line would be equal to $\frac{R}{2}$, R being the total resistance of the line; but as the major part of the charge is near the charging battery, the charging resistance is a quantity smaller than $\frac{R}{2}$. The retardation is proportional to the quantity r. Next consider the effect of adding the return wire (fig. 2). The resistance of this return wire will have the effect of decreasing the fall of potential along *x b* to half the value in fig. 1, and of increasing the charging resistance to $2\,r$. Now, as both lines are charged simultaneously, the retardation is proportional to the time taken to give *x b* (fig. 2), the charge *a x b* through a resistance $2\,r$; and *a x b* (fig. 2) having half its value for fig. 1, the time remains constant, or nearly so. Again, if the E.M.F. be doubled to retain the same current strength, *x b* will have the same charge as in fig. 1, but with double the charging potential difference, thus doubling the rate of charging and keeping the time exactly the same. Next consider the retardation due to discharge of the line. In fig. 1, the line will discharge through each end on disconnecting the battery and joining to earth, but principally to x; or, at a certain point nearer x, the charges on each portion of the line will discharge simultaneously in opposite directions through two different resistances. The total charge, therefore, really discharges through the parallel resistance of these two resistances. Let this parallel discharging resistance be r_1. It is easily seen that r_1 is less than r, therefore the line takes longer to charge than to discharge. In fig. 2, with double the E.M.F., each line possesses an equal charge to fig. 1, but of opposite sign to one another, and as these charges neutralise one another at the loops, and also discharge simultaneously, the time thus taken is simply proportional to the discharging resistance of either line, which is, of course, the same as in fig. 1. I may mention that this explanation does not take into account the slight error which would arise through the self-induction of the circuit causing Ohm's law to fail in some degree. This would cause a small error in the calculated values of r and r_1.

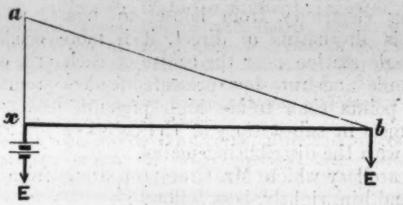


FIG. 1.

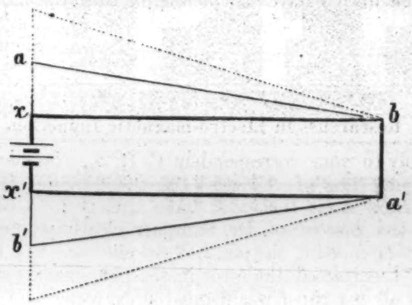


FIG. 2.

J. E. Taylor.

Telegraphists' School of Science,
Central Telegraph Office, E.C.

[Mr. Taylor is incorrect in saying that "it stands to reason that the absolute capacity of such a system is increased by using a return wire." As a matter of fact (and it admits of easy proof) the capacity of two looped "cables" *without earth used* is *half* that of one of the cables *with earth used*; the first case (that of the looped cables) is like that of two condensers joined up "in cascade," the capacity of the combination being *one half* that of a single condenser. The point requiring explanation is what are the conditions in the case of two looped *ærial* lines when the wires are parallel and close together.—EDS. ELEC. REV.]

Lightning Conductors.

In reply to your editorial in the ELECTRICAL REVIEW of May 15th, I enclose a copy of my paper before the American Institute of Electrical Engineers and of the discussion reprinted from *Science*. I think my remarks will make clear that I base my method of lightning protection on the fact that in every case of lightning stroke on record that I now know of, the dissipation of a conductor has furnished complete protection for all points between two horizontal planes passing through the upper and lower ends, respectively, of the dissipated conductor. There are numerous cases like that described by Franklin to be found recorded in the "Philosophical Transactions," especially about the time when the Royal Society was most concerned with lightning—one hundred and forty years ago. You would confer a great favour by encouraging a discussion of this matter of fact; but, of course, the only mode of discussion is to cite from the records: arguing as to the reasonableness or otherwise of a simple question of fact is not to the point.

The enclosed circular may make clearer the method of application of my dispeller.

N. D. C. Hodges,
Editor of Science.

New York, *May 26th.*

[We insert in our present issue an abstract of the discussion on Mr. Hodges's paper. Mr. Hodges's argument seems to be that there are any number of cases in which buildings provided with conductors which could not be dissipated, have been damaged, but none in which the reverse has taken place; this is not a very conclusive argument, seeing that the protectors of Mr. Hodges have been in existence a very short time only, whilst the accepted form of conductor is old. What number of protectors on the Hodges principle have been put up, and in how many cases have they been struck? It may be mentioned that the dispeller, as Mr. Hodges calls his protector, consists of about 75 feet of light copper ribbon cut in short strips, with insulating washers at each joint; the ribbon is nailed along the roof ridges and the extreme ends brought down to the ground, but not terminated by earth plates.—EDS. ELEC. REV.]

"Induction in Multiple Core Cables."

Those of your readers who are more intimately connected with the telegraphic branch of electrical engineering will have noted with much interest Messrs. Dresing and Gulstad's

"Remarks on Induction in Multiple Core Cables," published in the issues of the 8th and 22nd ult. Too much credit can scarcely be given to the Great Northern Telegraph Company's engineers for the patience with which they have worked at a very difficult problem, and for the ingenuity they have shown in applying to submarine cables Prof. Hughes's device for compensating for induction effects on ordinary telegraph lines. But the difficulties incidental to the application of this method, so well brought out in Messrs. Dresing and Gulstad's paper, become practically insurmountable when the length of the line operated upon is materially increased; and, instead of employing such very troublesome methods to compensate for the disturbances, it will, I believe, be universally admitted that the more satisfactory plan would be to eliminate the disturbances altogether.

It will therefore not be out of place for me to remind your readers that an absolutely perfect method of dealing with this problem was devised by me and patented by Messrs. Siemens Bros., & Co., in the year 1882. By this method (which is applicable to any land line or cable, of any length) all induction disturbances, however caused, are completely removed.

The method consists, briefly stated (to take the simplest case of a line or cable with two conductors), in first forming a metallic circuit by looping the two conductors, and then forming a second circuit over the two conductors combined as a single wire, with earth as the return. Resistances, condensers, or both together (the precise arrangement depending on the length of the line and the type of instruments employed) are connected at each station, duplex-bridge-wise, to establish equality of potential between the ends of the conductors, and it can be seen that when balance is established the metallic circuit with its instruments will remain entirely unaffected by any currents passing over the "earth circuit," and *vice versa*. In the case of lines containing a larger number of conductors, these would first be divided up into simple metallic loops, and then by balancing the separate metallic circuits and treating them as single conductors, as described above, further metallic circuits would be furnished from them as required. The whole operation of balancing is almost as simple as that of taking an ordinary Wheatstone bridge test, and the balance, once established, remains unaltered for years—any climatic changes affecting, of course, both sides of the balance equally.

The plan of employing properly arranged metallic circuits to eliminate the effects of induction is well-known to be an efficacious one, but the fact that its adoption reduces the number of working circuits to half that of the number of wires on the line constitutes in most cases a fatal objection to its use. The great merit of my device lies in this: that it is able to afford all the advantages of metallic-circuit working without any reduction in the number of working circuits. In fact, it gives as many circuits as there are wires, just as though the lines were worked in the ordinary way, but with each circuit entirely independent of, and free from any interference from, the rest.

The system has been in use for the past seven years on the Commercial Cable Company's two-core cable, connecting Nova Scotia with the United States. This cable is about 520 knots long. Sir W. Thomson's siphon-recorder is used on one circuit and a relay of the Brown and Allan type on the other, with perfect success and freedom from mutual interference between the circuits. The balance has required no attention since first put up. The same company also uses the system on a two-core cable connecting their stations at Weston-super-Mare and Waterville (Ireland). This cable is about 330 knots long, and the connection between the cable end at Weston-super-Mare and the office in London is made by overhead wires about 140 miles in length. Working is carried on direct between London and Waterville with automatic translation at Weston-super-Mare, and this case is even more interesting than the foregoing, as one of the circuits from London to Waterville is duplexed in the ordinary way.

I am further permitted, by the kindness of Mr. W. H. Preece, to mention that he has tried this system between London and Sangatte (*i.e.*, over about 84 miles of land line and 21 knots of cable) on the London-Paris telephone line, with perfect success and absolute non-interference between the two circuits worked over the same pair of wires. He used telephones on one circuit while a Wheatstone automatic apparatus was working at the rate of 200 words per minute on the other, and no better proof of the value of the system can be desired than is afforded by the success of this experiment.

F. Jacob.

Charlton, *8th June*, 1891.

The Relative Cost and Economy of High and Low Pressure Central Stations.

I have read Mr. Crompton's reply to my criticisms on his paper with much interest, and am only sorry he was unable to be at the meeting at the Institution of Electrical Engineers when his paper was discussed so that the method and data on which he made up his calculations might have been explained more fully and clearly at the time.

I do not yet altogether agree with Mr. Crompton's figures on the cost of A.T. feeders, but as the difference between us would not now amount to a large percentage on the cost, I am content for myself to sink this for a time in view of the magnitude of the issue which Mr. Crompton puts before us, and which I at any rate, and I think most people so far, have failed properly to appreciate.

The position which Mr. Crompton takes up in his paper, and which he has been kind enough to explain to me more fully in private conversation is, if I understand him correctly, briefly this:—

Granting that a low tension network on the three-wire system with feed points is the cheapest and best way of supplying electricity from house to house, whether the current is alternating or direct, it is more economical to put a single station near the centre of each area of about a square mile and run low pressure feeders from it to the feeding points than to use high pressure feeders and put transformers in sub-stations at the points where the feeders connect with the distributing mains.

The corollary which Mr. Crompton draws from this, if I understand him rightly, is as follows:—

In establishing a central station for lighting a town, by adopting the low pressure three-wire system I have done the best thing both for the present and the possible eventualities of the future. I can sell a unit of current in the low pressure station as cheaply as in the high and I am safe whatever happens, because if, as is possible, extreme high pressures may come into use later on, my network of mains and station will still be the cheapest way of distributing the current locally, and all I shall have to do will be to remove my machinery, put transformers in the place of it and let off the greater part of my buildings as warehouses, or for some other purposes.

For my own part I am inclined to think this view is, on the whole, correct, though I do not wish to absolutely commit myself until I have had more time to think it over more fully.

S. L. Addenbrooke.

Researches in Electro-magnetic Induction.

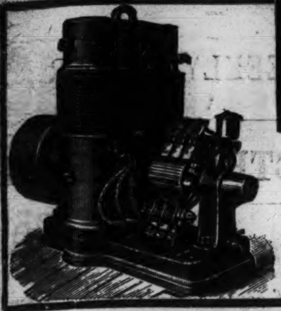
In reply to your correspondent C. G. S., who takes exception to my use of "dynes" as the unit of H in my paper, I may state that as I have already mentioned in a letter to the *Electrician*, Dr. Sumpner clearly pointed out to me after the meeting the point where our reasoning had gone wrong. I corrected the error in the proof sent me by you, but after all my paper was printed uncorrected and contains several misprints. The proof only reached me on Thursday morning, and was returned to you by the evening of that day.

I am glad to find that "C. G. S." has no objection to the "Thom" and the "Gauss"; but the units were invented for private use, and it is of no importance whether they are accepted or not. We shall be happy to use the authorised unit when it is officially adopted.

Ernest B. Vignoles.

June 10th, 1891.

[Mr. Vignoles evidently overlooked the note on p. 727 of our last issue which was printed to save him the trouble he has now taken.—EDS. ELEC. REV.]



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[*Continued on next Page.*]

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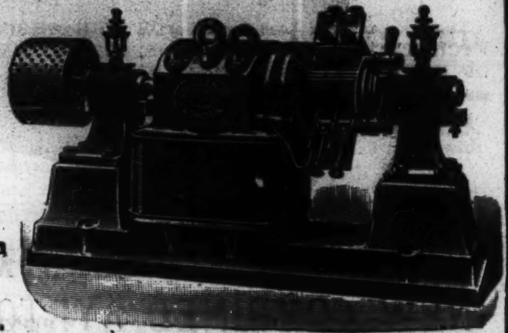

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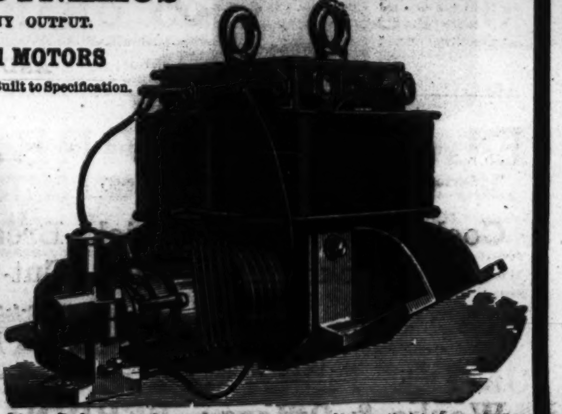

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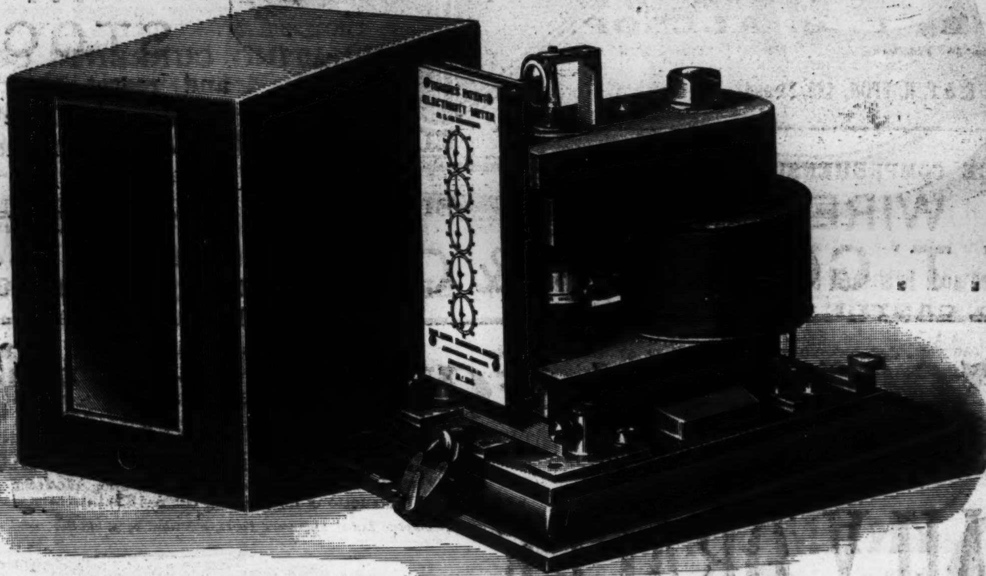

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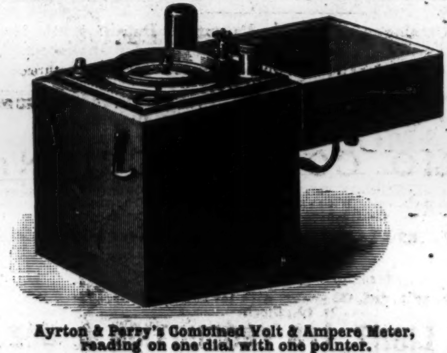

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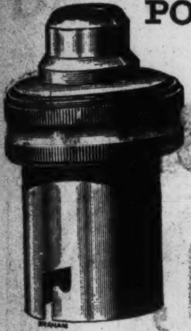

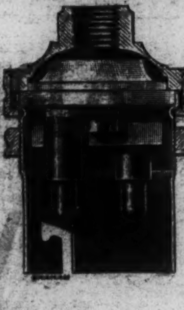

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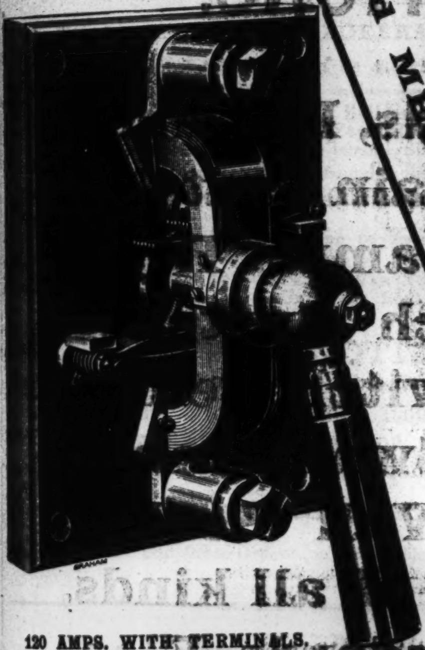

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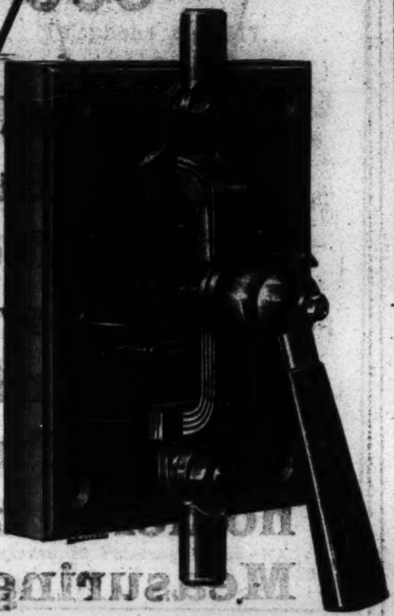

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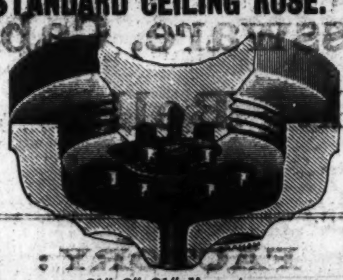

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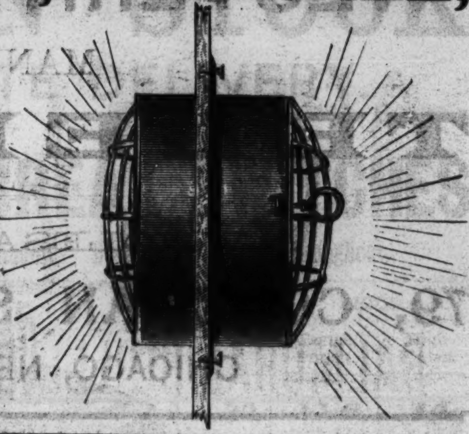

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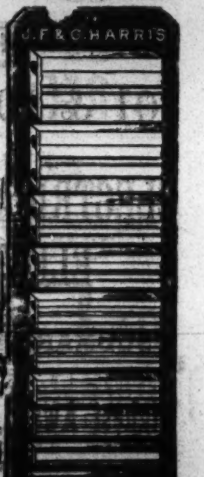

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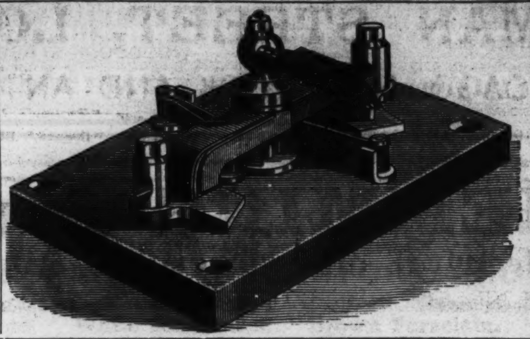
65	To carry		30	11/6	14/-
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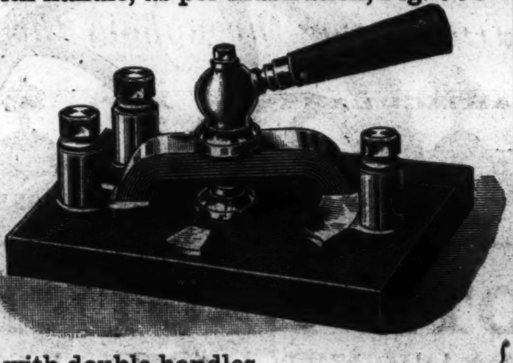
75	2 " 	"	28/-
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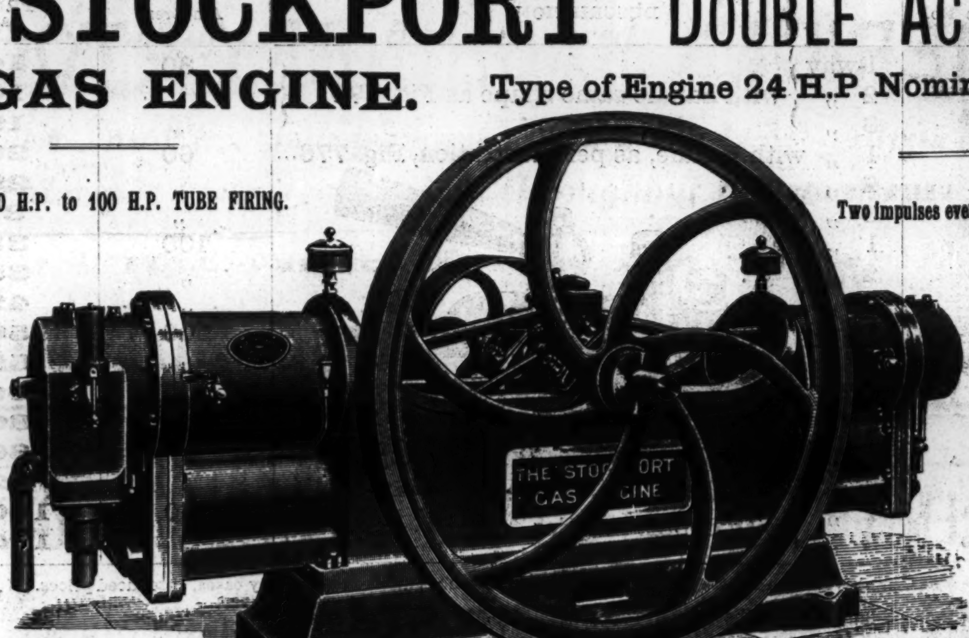

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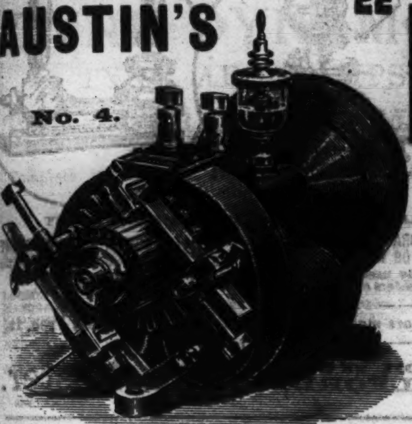

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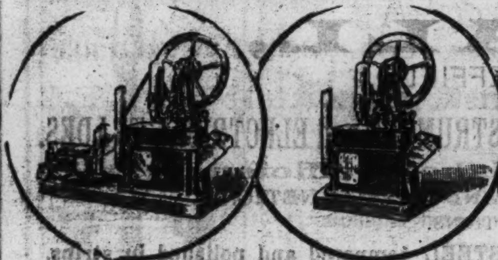

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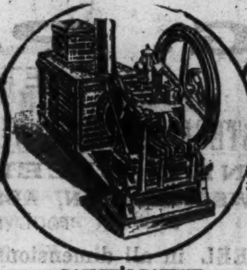

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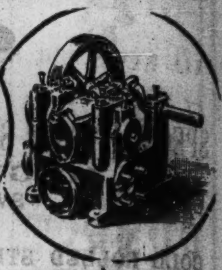

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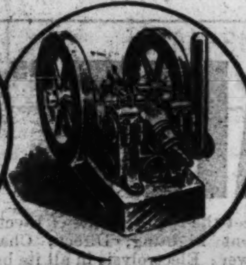

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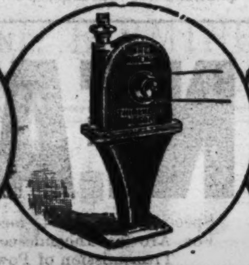

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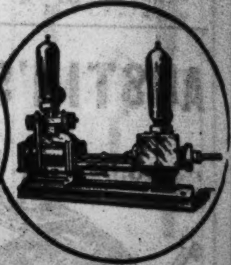

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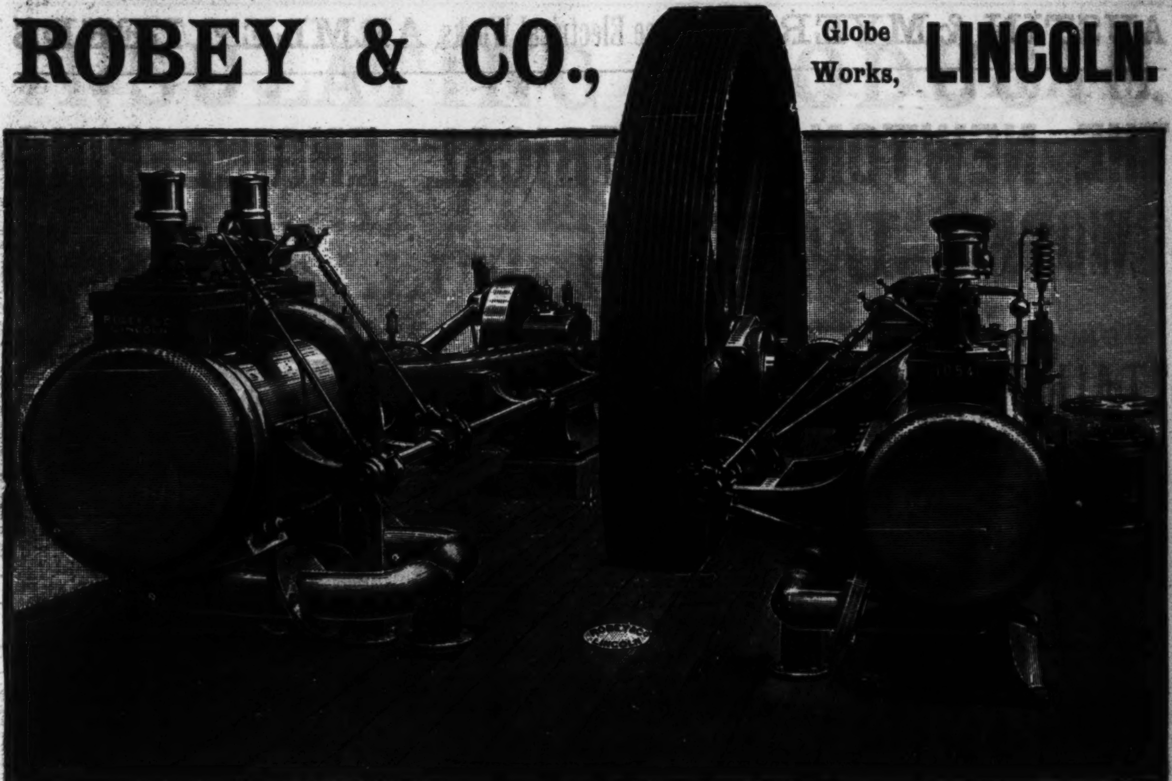

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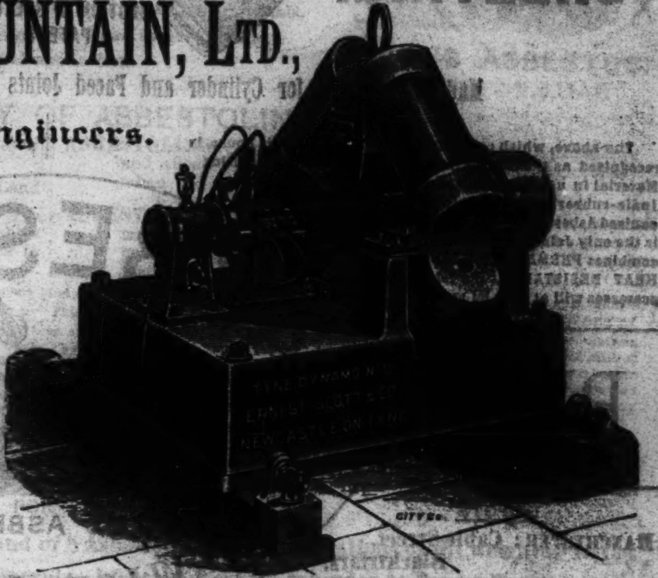

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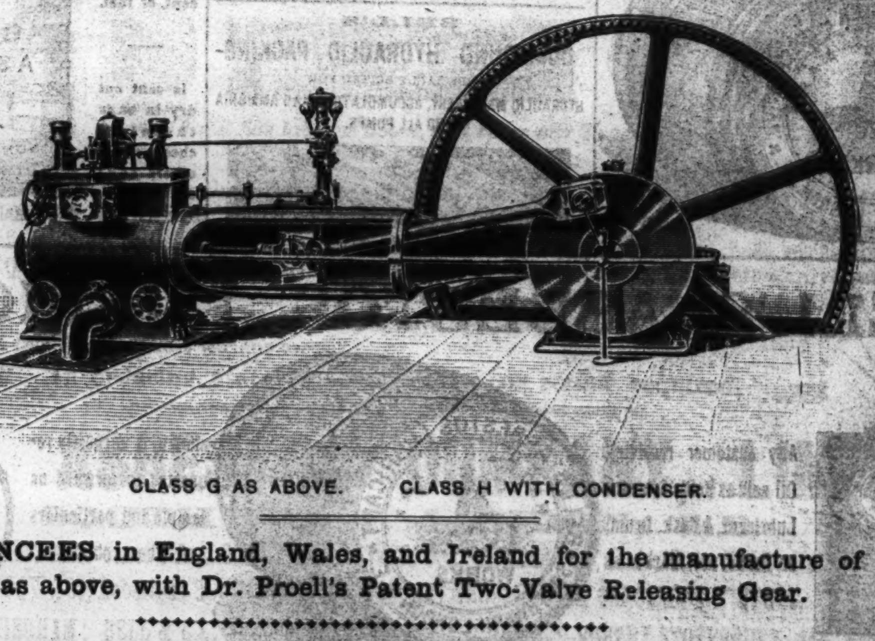

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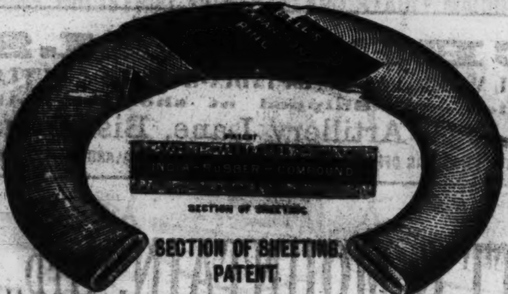

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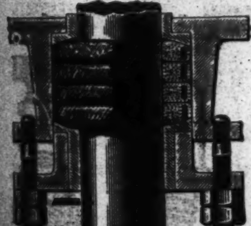

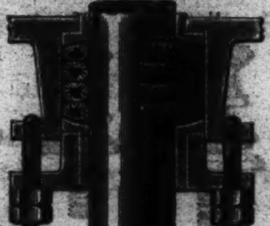

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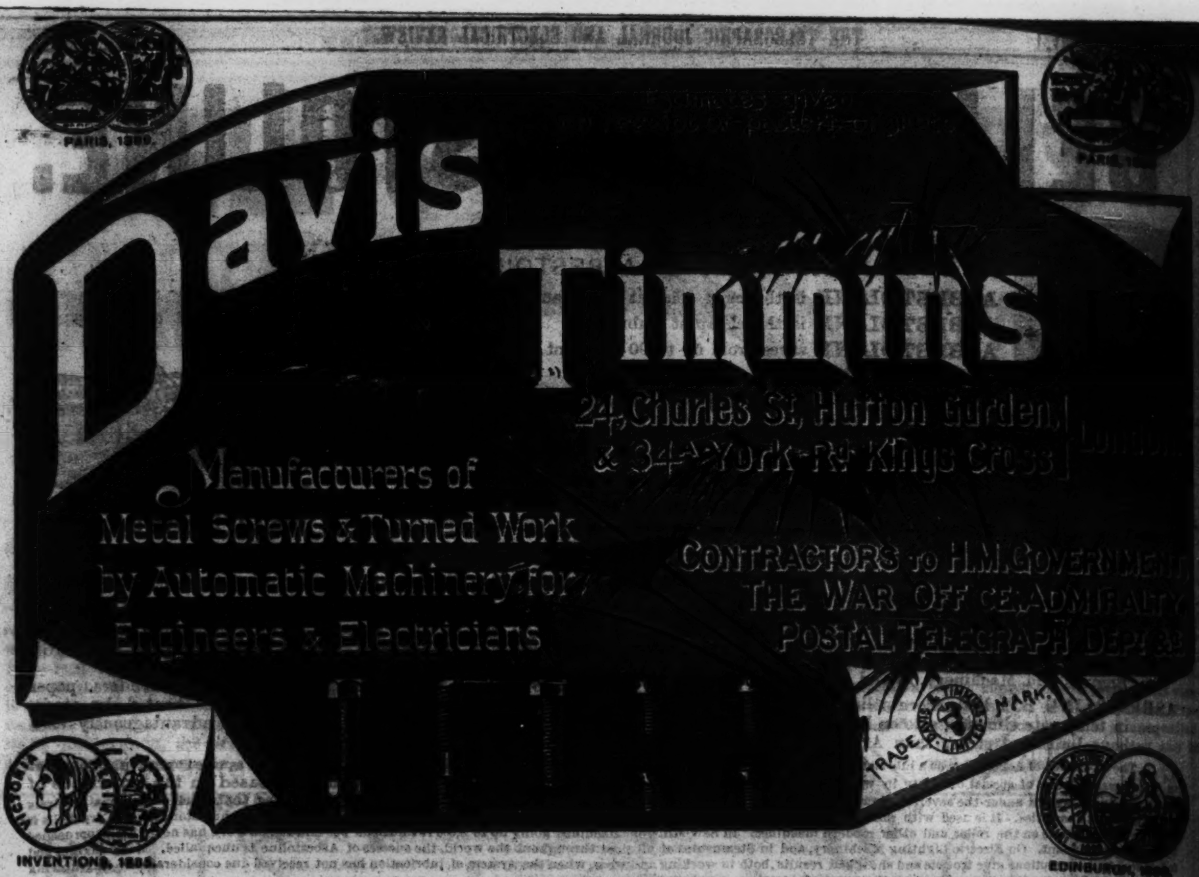

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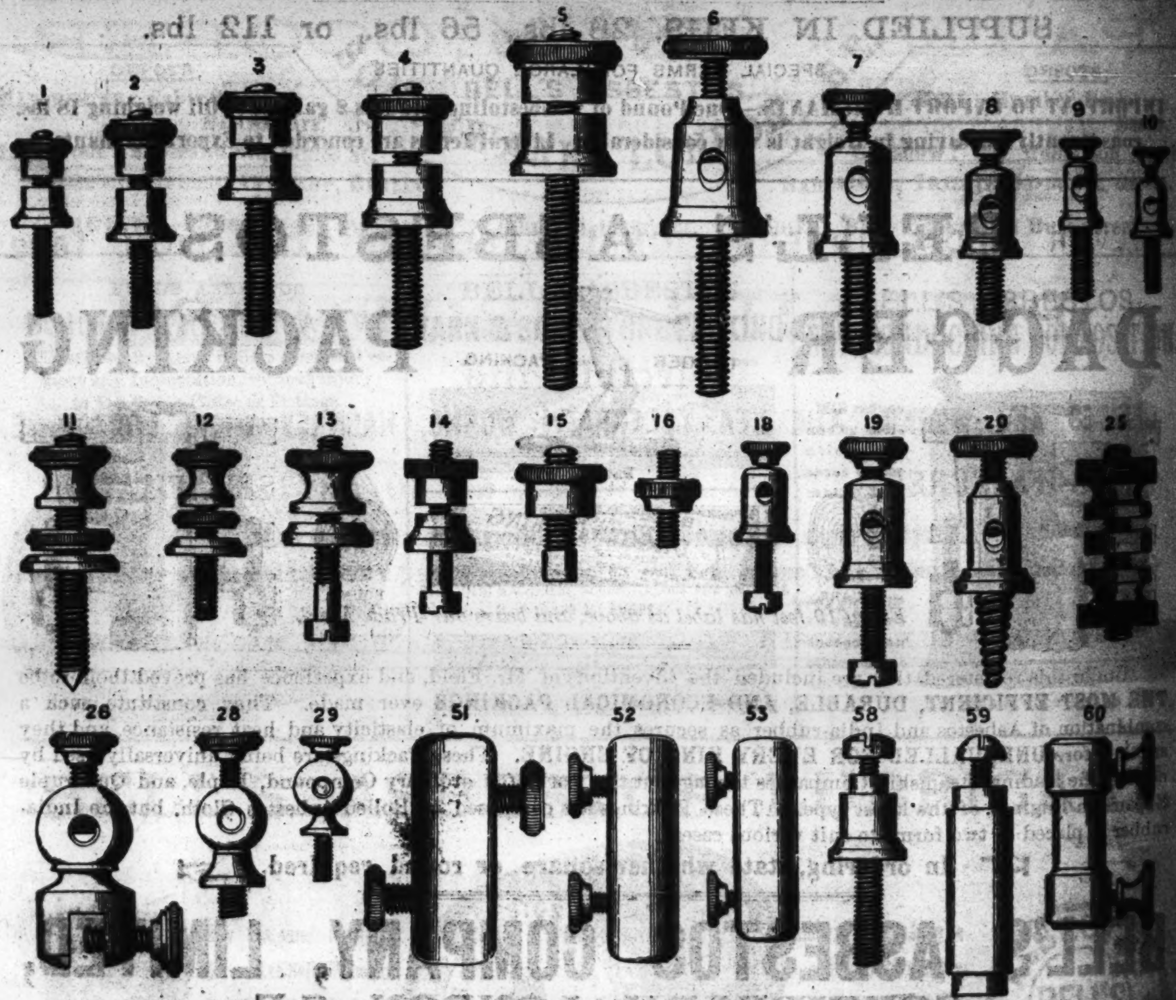

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